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Old Bones

or Notes for Young Naturalists.

OLD BONES.

Old Bones

OR

NOTES FOR YOUNG NATURALISTS,

by

THE REVD. W. S. SYMONDS, F.G.S.

RECTOR OF PENDOCK

BIBLIOTHECA BODLEIANA

C. S. Fecit.

Vincent Brooks lith. Chandos St Covent Garden.

London.

ROBERT HARDWICKE, 192, PICCADILLY.

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LONDON:
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1861.

~~488. c. 14~~.

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BIBLIOTHECA · BODLEIANA ·

TO

SIR CHARLES HASTINGS, M.D.

PRESIDENT OF THE NATURAL HISTORY SOCIETY OF WORCESTER.

MY DEAR SIR CHARLES,

THIS little Work is prepared from a series of Notes made when engaged in the study of the Vertebrata and their fossil allies; and a considerable portion of the first chapter was given, at the commencement of the present year, in an address delivered at the request of yourself and the Council of the Natural History Society of Worcester.

I now publish it in the hope that it may prove useful to the Student, when he has the opportunity of visiting any of the various Museums or Zoological Gardens of our Native land, as I believe that the knowledge acquired from books becomes far more practical when impressed upon the mind by a careful examination of the works of Nature.

The kind sympathy with which you are ever ready to cheer the Naturalist in search of truth, encourages me to dedicate to you the following pages; while I would also express my gratitude to several distinguished Naturalists who have assisted me in carrying them through the Press.

Believe me, dear Sir Charles,

Yours very faithfully,

W. S. SYMONDS.

PENDOCK RECTORY, TEWKESBURY,
January, 1861.

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OLD BONES.

INTRODUCTION.

It has been eloquently and truly said, that everything in Nature is engaged in writing its own history: "the planet and the pebble are attended by their shadows, the rolling rock leaves its furrows on the mountain-side, the river its channel in the soil, the animal its bones in the stratum; the fern and leaf inscribe their modest epitaphs on the coal, and the falling drop sculptures its story on the sand and on the stone;" yet it must not be imagined that the revelations of that history will be divulged to those who seek them not, for Nature's truths are "whispered rather than outspoken."

Many persons, in a scientific age, would become scientific without the labour of study, and imagine that knowledge may be acquired by some popular, but ideal method, requiring no more mental fatigue or patient research than reading a novel or perusing a love ditty. Ladies would fain study chemistry as they sigh over the last new novel; while the "sworn horse-courser" wonders that the marvels of astronomy are not so much adapted to his capacity for knowledge as are the lucubrations of the Racing Calendar, or that the perigee is more intricate than the pedigree of an "Eclipse."

There are men believing themselves educated, who "occupy themselves with trivialities, and are indifferent to the grandest phenomena—care not to understand the architecture of the heavens, but are deeply interested in some contemptible controversy about the intrigues of Mary Queen of Scots—are learnedly critical over a Greek ode, and pass by without a glance that grand epic written by the finger of God upon the strata of the earth!"—while others, possessing very limited means and opportunities of studying God's works, nevertheless, as far as those means allow, do study them, and find a great increase of happiness arising from the pursuit of such knowledge, and of the gifts that Nature has in store for the humblest of her disciples.

In these pages I shall endeavour to explain how any person, wishing to become acquainted with the leading principles of Natural History, may, by pursuing the study with system and method, proceed from one subject to the other without falling into the maze of intricacy which generally besets those who commence such investigations without method, and who are altogether ignorant of the first elements that constitute a single branch of that far-spreading tree whose roots are planted in the depths of remotest time, and whose upper boughs are ever growing upwards and onwards to the remotest future.

I have had personal experience of the necessity of beginning at the right end. Many years ago I commenced the study of fossil shells and plants, without the slightest knowledge of the history of the animals that inhabit recent shells, or of the physiology of living plants, and, as a natural consequence, I became confused with terms and definitions of which I knew nothing, and, like the youth who is crammed with Virgil before he has mastered the Latin grammar, had to endure the mortifying discovery, that after months of study I was still an utter ignoramus.

"Natura non facit saltum" is an old adage, and its truth is now being realized throughout the whole history of the animal and vegetable kingdom, past and present; from the creation of the oldest known Cambrian fossil to the creation of spiritual and intellectual man.

The contemplation of the animal kingdom reveals a wondrous unity of plan and of structure; and, notwithstanding the vast numbers of animals that now exist on this planet, we learn that all have been constructed upon a *few original types.*

PRIMARY DIVISIONS.

The animal kingdom was divided by the celebrated Cuvier into four sub-kingdoms—VERTEBRATA, MOLLUSCA, ARTICULATA, RADIATA. Recent naturalists, however, have separated certain organisms, called PROTOZOA, from the Radiata, and thus have erected five sub-kingdoms, which are arranged as follows:—

1. *Vertebrata.*—Animals that have a backbone and internal skeleton; as man, birds, reptiles, fish.

2. *Mollusca.*—Soft-bodied animals, at the head of which are ranked the nautilus and cuttle-fish, with their allies, the *extinct* belemnites, ammonites, and orthoceratites; and which include the shell-bearing animals, as sea-snails, welks, cowries, mussels, oysters, terebratulæ, lingulæ, &c.

3. *Articulata.*—Jointed animals; as insects, centipedes, scorpions, spiders, lobsters, cyclops, barnacles, and the extinct trilobites and eurypteri.

4. *Radiata*, or *Cœlenterata.*—Rayed animals. This sub-kingdom includes sea-cucumbers, sea-urchins, starfish, crinoids (or stone lilies), corals, and the extinct pentremites, cystideans, and graptolites.

5. *Protozoa.*—Minute beings "retaining the form of nucleated cells, which manifest the common organic

characters, but without the distinctive superadditions of true plants or animals."* Sponges, foraminifera, and infusorial animalcules are included in this sub-kingdom.

These plans of animal architecture are altered and modified in a thousand ways. However ungallant, it is more necessary to separate the "lassie fair and gentle" from the nightingale and dove, than from the hippopotamus or whale; while the winged butterfly of the air is far more nearly allied to the centipede or scorpion than it is to the humming-bird or bat.

The sub-kingdoms, therefore, are divided into CLASSES, ORDERS, FAMILIES, GENERA, SPECIES.

Vertebrate animals are divided into four Classes—MAMMALS, BIRDS, REPTILES, and FISHES.

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* "Palæontology," by Professor Owen, p. 4.

PLATE

1 CARNIVOROUS TEETH.

2 GUADALOUPE SKELETON.

3 SKULL OF A MACACUS

4 SKELETON OF MAN

5 TEETH OF AN HERBIVORE

6 HUMAN TEETH

7

8 SKULL OF A BEAR

9 THE GALEOPITHECUS.

CHAPTER I.

CLASS I.—MAMMALIA.

Animals that suckle their young.

The Class Mammalia is divided into different Orders, and the following is the recent classification of Professor Owen :—

ARCHENCEPHALA (*perfect-brained*).

Order 1. **BIMANA** (*two-handed animals*)—man.

GYRENCEPHALA (*convolute-brained*).

" 2. **QUADRUMANA** (*four-handed animals*)—monkeys of the old world, American monkeys, lemurs.

" 3. **CARNIVORA** (*flesh-eaters*) — lion, wolf, hyena, bear, racoon, badger, seal, morse.

" 4. **ARTIODACTYLA** (*even-toed, two or four, animals*)—hippopotamus, pig, camel, stag, cow, sheep.

" 5. **PERISSODACTYLA** (*odd-toed, one or three, animals*) — horse, rhinoceros, hyrax, tapir.

" 6. **PROBOSCIDEA** (*animals with a proboscis*)—elephants.

" 7. **TOXODONTIA** (*an extinct family, three species of which are known from rocks in South America*)—toxodon.

" 8. **SIRENIA** (*sirens*)—dugong, manatee.

" 9. **CETACEA** (*whale animals*)—whale, porpoise, dolphin.

LISSENCEPHALA (*smooth-brained*).

" 10. **CHEIROPTERA** (*hand-winged animals*)—pteropus, bats, vampire.

" 11. **INSECTIVORA** (*insect-eaters*)—hedgehog, shrew, mole.

" 12. **EDENTATA** (*animals wanting teeth in the fore part of their jaw*)—sloth, armadillo, anteater.

" 13. **RODENTIA** (*gnawers*)—rat, hare, squirrel, beaver, porcupine.

LYENCEPHALA (*loose-brained*).

" 14. **MARSUPIALIA** (*pouched animals*)—kangaroo, wombat, opossum, dasyurus, koala, &c.

" 15. **MONOTREMATA** (*single-vented animals*) — platypus, echidna.

Order 1.—BIMANA.

Man.

The ancient history of the human race, and the question whether a rude, primitive race of men existed at an epoch far more remote than is usually ascribed to the creation of man, now excites considerable interest.

Certain flints have been found, in post-tertiary deposits, that appear to have been fashioned by human hands into tools and implements of warfare and the chase. The geological age of these post-tertiary deposits has been determined to be immensely remote when compared with the chronology of the Jews, or the annals of history or tradition. With regard to the human manufacture of the flints, I am no archæologist, and will not express an opinion; but with respect to the age of the beds, having heard and read the evidence of such men as Boucher de Perthes, Lyell, Prestwich, and Falconer, I should as soon think of believing that Professor Owen was incapable of detecting the difference between the skeleton of a lion and an ass, or that my friend Mr. Lees * could not distinguish a primrose from a "daisy trim," as of questioning the authority of the geologists I have mentioned, upon the age of those particular post-tertiary deposits, upon which they have expended so much of the labour of their lives, and upon which they have brought to bear every expedient of experience and research.

Many questions occupy the attention of philosophers respecting the primordial organic type of humanity, the unity of the race, and indigenous races of men. Those who take an interest in speculating on such intricate problems will find food for thought in the enormous difference between man degraded, and man elevated, educated, and spiritualized; between the

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* The Worcestershire botanist.

idolatrous savage and the lord of the telescope, the steam-engine, and the electric telegraph.

The theology of science is at present in its infancy, and consequently liable to multitudes of errors. When the theologian shall have become more conversant with God's works, and the scientific man more of a theologian, we shall obtain more light. The laws of creation are the laws of God, and so also is the law of revelation to man's spirit.

Without referring to the subject under its religious aspect, I conceive that science teaches that there is an impassable hiatus between the intellectual capacities of the lowest race of men and those of the highest race of apes.

It is impossible to select a more degraded race of men, for example, than the Rock Veddahs, so graphically described by Sir Emerson Tennent, in his admirable work on Ceylon.

"Their language is limited to a very few words; and so degraded are some of these wretched outcasts, that it appears doubtful in certain cases whether they possess any language whatever. . . . They have no knowledge of a God, nor of a future state; no temples, no idols, no altars, prayers nor charms; and, in short, no instinct of worship, except, it is reported, some addiction to ceremonies analogous to devil-worship, in order to avert storms and lightning. . . . So rude are the Veddahs in all respects, that they do not even bury their dead, but cover them with leaves and brushwood in the jungles. . . . In form they are miserable objects, active but timid, and athletic though deformed, with large heads and misshapen limbs."

They have "projecting mouths, prominent teeth, flattened noses, stunted stature. . . . The children are unsightly objects, entirely naked, with misshapen joints, huge heads, and protuberant stomachs; the women the most repulsive specimens of humanity ever seen in any country. . . . The Rock Veddahs have no idea of time or distance; no name for hours, days, or years. They have no doctors, and no knowledge of medicine beyond the practice of applying bark and leaves to a wound. They have no games, no amusement, no music; and as to education, it is so utterly unknown that the wild Veddahs are unable to count beyond five on their own fingers." I do not think it possible to select examples of men degraded, more striking than these savages of Ceylon. Yet we must never forget that these Veddahs showed, on the very first attempt of civilization, that they possessed the human element of progress and improvement. In one colony, at Oomany, so remarkable is the change that the whole community have become Christians. "Their former appellation, derived from the peculiarity of their habits, can no longer apply; the distinction of Rock Veddahs has ceased to exist in that part of the country; all having more or less adopted the habits of villagers."

The Bushman of Africa is another instance of what we may term a degraded man; or, at least, of an intellectually undeveloped man; yet, however degraded the man may be, he possesses the power of progress; he has been endowed with mental faculties capable of improvement, which education immediately tends to develop.

The earliest record of the existence of man, as an inhabitant of this planet, is immensely posterior to that Dawn epoch (Eocene) in which the oldest known ape, the Eopithecus, is known to have lived. Our first knowledge of man is that he appears as a reasoning being. Apes were apes myriads of ages before we have any evidence of man's existence, and are apes still.

The oldest human bones are contemporaneous with our recent animals. The oldest human implements are from Glacial (?) drifts in France. These are associated with the bones of animals, some of which are extinct throughout the continent of Europe. The fossil skeleton of a woman from Guadaloupe, in the British Museum, is from a raised beach, and comparatively recent.

Order 2.—QUADRUMANA.

Four-handed animals.

The term quadrumana (four-handed) is applied to animals the extremities of whose limbs resemble the human hand, so that they climb with ease. This order is subdivided into three families:—

1. CATARHINI (Old-World monkeys).
2. PLATYRHINI (American monkeys).
3. STREPSIRHINI (Lemurs).

The apertures of the nostrils in these groups present distinguishing features. As an instance of the difficulty of drawing a broad line of demarcation between those animals which appear to afford intermediate links of transition, I would draw your attention to the Lemurs, one of which, the flying Lemur, seems to connect the four-handed animals or monkeys with the wing-handed animals or bats. The Lemurs inhabit the island of Madagascar, and Cuvier ranked the winged Lemur (Galeopithecus) with the bats. Some comparative anatomists believe that there is a gradation from the monkeys through the Lemurs, Galagos, and Galeopithecus, to the bats.

For an account of the comparative anatomy of the most highly developed apes, I cannot do better than refer my readers to the elaborate paper by Professor Owen on the far-famed Gorilla.*

In structure, the gorilla offers the nearest approach to man of any known ape, recent or fossil. Professor Owen, when comparing the structure of the highest of the Quadrumana with man, thus expressed himself at the late meeting of the British Association at Oxford:—

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* "On the Gorilla" (*Troglodytes Gorilla*), Proc. Zool. Soc. of London, Jan. 11, 1859.

> "Taking the brain of the gorilla, it presented more differences, as compared with the brain of man, than it did when compared with the brains of the very lowest and most problematical form of the Quadrumana. The deficiencies in cerebral structure between the gorilla and man were immense. The posterior lobes of the cerebrum in man presented parts which were wholly absent in the gorilla. The same remarkable differences of structure were seen in other parts of the body; yet he would especially refer to the structure of the great toe in man, which was constructed to enable him to assume the upright position; whilst in the lower monkeys it was impossible, from the structure of their feet, that they should do so."*

We should not, however, be dealing fairly with our readers, if we did not state that at least one distinguished comparative anatomist differs from Professor Owen on the brain structure of the Gorilla. At Oxford, Professor Huxley replied at some length to the remarks of Professor Owen:—

> "He denied altogether that the difference between the brain of the gorilla and man was so great as represented by Professor Owen, and appealed to the published dissections of Tiedemann and others. From the study of the structure of the brain of the Quadrumana, he maintained that the difference between man and the highest monkey was not so great as between the highest and the lowest monkey. He maintained also, with regard to the limbs, that there was more difference between the toeless monkeys and the gorilla, than between the latter and man. He believed that the great feature which distinguished man from the monkey was the gift of speech."

With regard to the habits and nature of the gorilla, the following is the interesting description given by Professor Owen in the paper on the gorilla, already alluded to:—

> "Gorilla-land is a richly-wooded extent of the western part of Africa, traversed by the rivers Danger and Gaboon, and ex-

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* *Athenæum*, July 7, 1860.

tending from the equator to the 10th or 15th degree of south latitude. The part where the gorilla has been most frequently met with, presents a succession of hill and dale, the heights crowned with lofty trees, the valleys covered by coarse grass, with partial scrub or scattered shrubs. Fruit-trees of various kinds abound both on the hills and in the valleys; some that are crude and uncared for by the Negroes are sought out and greedily eaten by the gorillas; and as different kinds come to maturity at different seasons, they afford the great denizen of the woods a successive and unfailing supply of indigenous fruits.

"Fruits and other rich and nutritious productions of the vegetable kingdom, constitute the staple food of the gorilla, as they do of the chimpanzee. The molar teeth, which alone truly indicate the diet of an animal, accord with the statements as to the frugivorous character of the gorilla; but they also sufficiently answer to an omnivorous habit to suggest that the eggs and callow brood of nests discovered in the trees frequented by the gorilla might not be unacceptable.

"The gorilla makes a sleeping-place like a hammock, connecting the branches of a sheltered and thickly-leaved part of a tree by means of the long tough slender stems of parasitic plants, and lining it with the broad dried fronds of palms, or with long grass. This hammock-like abode may be seen at different heights, from 10 to 40 feet from the ground, but there is never more than one such nest in a tree.

"They avoid the abodes of man, but are most commonly seen in the months of September, October, and November, after the Negroes have gathered their outlying rice-crops, and have returned from the 'bush' to the village. So observed, they are described to be usually in pairs; or, if more, the addition consists of a few young ones, of different ages, and apparently of one family. The gorilla is not gregarious. The parents may be seen sitting on a branch, resting the back against the tree-trunk—the hair being generally rubbed off the back of the old gorilla from that habit—perhaps munching fruit, whilst the young gorillas are at play, leaping and swinging from branch to branch, with hoots or harsh cries of boisterous mirth.

"If the old male be seen alone, or when in quest of food, he is usually armed with a stout stick, which the Negroes aver to be the weapon with which he attacks his chief enemy the elephant. Not that the elephant directly or intentionally injures the gorilla, but, deriving its subsistence from the same source, the ape regards the great proboscidian as a hostile intruder. When, therefore, he discerns the elephant pulling down and wrenching off the branches of a favourite tree, the gorilla, stealing along the bough, strikes the sensitive proboscis of the elephant with a violent blow of his club, and drives off the startled giant trumpeting shrilly with rage and pain.

"In passing from one detached tree to another, the gorilla is said to walk semi-erect, with the aid of his club, but with a waddling awkward gait; when without a stick, he has been seen to walk as a biped, with his hands clasped across the back of his head, instinctively so counterpoising its forward projection.

"The young men of the Gaboon tribe make armed excursions into the forests, in quest of ivory. The enemy they most dread on these occasions is the gorilla. If they have come unawares too near him with his family, he does not, like the lion, sulkily retreat, but comes rapidly to the attack, swinging down to the lower branches, and clutching at the nearest foe. The hideous aspect of the animal, with his green eyes flashing with rage, is heightened by the skin over the prominent roof of the orbits being drawn rapidly backward and forward, with the hair erected, causing a horrible and fiendish scowl. If fired at and not mortally hit, the gorilla closes at once upon his assailant, and inflicts most dangerous, if not deadly wounds, with his sharp and powerful tusks. The commander of a Bristol trader told the author he had seen a negro at the Gaboon frightfully mutilated by the bite of the gorilla, from which he had recovered. Another negro exhibited to the same voyager a gun-barrel bent and partly flattened by the bite of a wounded gorilla, in its death-struggle. Negroes, when stealing through the gloomy shades of the tropical forest, become sometimes aware of the proximity of one of these frightfully formidable apes by the sudden disappearance of one of their companions, who is hoisted up into the tree, uttering, perhaps, a short choking cry. In a few minutes he falls to the ground a strangled corpse. The gorilla, watching his opportunity, has let down his huge hind hand, seized the passing negro by the neck, with vice-like grip, has drawn him up to higher branches, and dropped him when his struggles had ceased.

"The strength of the gorilla is such as to make him a match for a lion, whose tusks his own almost rival. Over the leopard, invading the lower branches of the gorilla's dwelling-tree, he will gain an easier victory; and the huge canines, with which only the male gorilla is furnished, doubtless have been assigned to him for defending his mate and offspring.

"The redeeming quality in this fragmentary history of the gorilla is the male's care of his family, and the female's devotion to her young.

"It is reported that a French natural-history collector, accompanying a party of the Gaboon negroes into the gorilla woods, surprised a female with two young ones on a large boabdad (*Adansonia*), which stood some distance from the nearest clump. She descended the tree with her youngest clinging to her neck, and made off rapidly on all-fours to the forest, and escaped. The deserted young one on seeing the approach of the men, began to utter piercing cries. The mother, having disposed of her infant in safety, returned to rescue the older offspring; but beforeshe could descend with it, her retreat was cut off. Seeing one of the negroes level his musket at her, she, clasping her young with one arm, waved the other, as if deprecating the shot. The ball passed through her heart, and she fell with her young one clinging to her. It was a male, and survived the voyage to Havre, where it died on arriving.

"A bold negro, the leader of an elephant-hunting expedition, being offered a hundred dollars if he would bring back a live gorilla, replied, 'If you gave me the weight of yonder hill in gold coins, I could not do it!'

"All the terms of the aborigines in reference to the gorilla imply their opinion of his close kinship to themselves. But they have a low opinion of his intelligence. They say that during the rainy season he builds a house without a roof. The natives on their hunting excursions light fires for their comfort and protection by night; when they have gone away, they affirm that the gorilla will come down and warm himself at the smouldering embers, but has not wit enough to throw on more wood, out of the surrounding abundance, to keep the fire burning,—'the stupid old man!'"

The Monkey-House at the Zoological Gardens in Regent's Park contains many species and characteristic forms of the monkey tribe, and entire skeletons of the gorilla may be seen in the British Museum. My friend Mr. Sclater describes the most characteristic species in the Zoological Gardens, in his Guide-book, sufficiently for the principles of study and examination.

Fossil remains of monkeys have been found in deposits of the tertiary ages in India, France, Greece, and England. Pithecus being the Greek name for monkeys in general, the fossil genera are named Eopithecus, Pliopithecus, Dryopithecus, &c., according to the characteristics exhibited by their fossil remains, or the age of the deposits in which they are discovered. A fossil species of Macacus was associated with the elephant and rhinoceros in England during the period of the later tertiary fresh-water deposits. Extinct species have been discovered in strata of the Dawn or Eocene epoch of geologists, as already mentioned.

Eocene is the term invented by Sir C. Lyell for the lowest and most ancient group of those tertiary rocks which succeed the secondary group of deposits in stratigraphical position, and in which the prototypes of almost all existing mammals for the first time make their appearance. Eocene means the Dawn of recent animals. The Miocene deposits, which succeed the Eocene tertiaries, contain fewer recent animals than the Pliocene, while in the Pleistocene deposits, which are the latest of the Pliocene, more than three-fourths of the fossils are of existing species.

The Eocene Period.

Species of shells are known to be much longer-lived than those of mammalia, and many species and genera of mammals have been called into existence, lived for ages, and become extinct, during the period that most of our common mollusks have been living in our seas.

The meaning of the term dawn, as applied to the life of former days, may be understood when we say, that of all the thousands of fossils, consisting of specimens of plants, shells, fish, reptiles, birds, and mammals disinterred from the Eocene tertiaries, only five per cent. of the shells are still living, and fewer of the other animals. During that dawn epoch, the sites of London and Paris were washed over by the waves of a rolling sea, tenanted by sharks and turtles. Rivers flowed into it and washed down the remains of strange tapir-like land quadrupeds, and among them the remains of monkeys. The trees that flourished on the land are known to be allied to the spice-trees and the palms by their leaves and fruit. Thus the climate of the dawn epoch in these latitudes is believed to have been warmer than the present climate of Great Britain.

The Miocene Period.

The proportion of living species of shells in these deposits is considered to be about 25 per cent. With the exception of some deposits at Hempstead, in the Isle of Wight, and some volcanic ash-beds, containing the remains of plants, associated with lavas, in the west of Scotland, we have no rocks of this age in Great Britain.

We know, however, from the revelations of these deposits in other lands, that the geographical changes of land and water surface have been enormous since the commencement of the Miocene epoch. The Atlantic rolls its waves over the site of an extinct continent that stretched its hills and vales north and south, east and west, in that Miocene epoch. During this period the volcanic mountains of central France were in full action, and there tuffs and ashes have preserved hundreds of relics of animals then living; while thousands of square miles of what was an ocean-bed during the Miocene period, have, in India, been elevated into lands, and now furnish hundreds of skeletons of extinct animals that were swept into the waters and preserved in silt and mud.

The Pliocene Period.

In rocks of this age, the number of fossil shells identical with forms now living, ranges from 50 to 70 per cent. The enormous lapse of ages that must have gone by between the close of the Pliocene period and the Recent or present period, may be gathered from the fact that the wondrous Glacial period intervened, with all the arctic phenomena, extending over thousands of years.

The Glacial and Pleistocene* Epochs.

One of the marvels revealed by the relics of animals and plants entombed in the rocks, is the fact that, as this planet circles in space around the sun, changes of climate are gradually brought about, though myriads of ages elapse between the commencement of such a change, the fulfilment of the epoch, its close, and the commencement of the change that ensues. I mentioned that in the Eocene epoch, the whole history of animal life, and plant life, tells us that a warmer climate than we now enjoy appertained to Great Britain, owing, probably, to certain geographical distributions of land surface, and water surface, to the history of which we have not found the clue. Ages and ages passed away, and even in the Pliocene epoch, during the deposition of a series of beds termed the Coralline crag, the presence of such shells as Pyrula, Cassidaria, Terebra, Voluta, prove a warmer, and, as it were, more southern influence in our seas.† Yet in the beds that succeed the Coralline crag (the Red crag), there is good proof of the commencement of a refrigeration of climate, and which refrigeration of climate went on for age after age, until glaciers filled every mountain valley in Scotland and Wales,‡ until the seas were floated over by drifting icebergs and icerafts, depositing their burdens of drifting boulders as they melted. The Glacial epoch passed away during the lapse of ages, and a more temperate climate succeeded; it may be to be again succeeded, in the far off futurity, by warmer and again by colder climatal influences than now affect our present temperate modifications.

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* A term signifying that the fossils found in Pleistocene deposits belong almost wholly to living species.

† Woodward on Recent and Fossil Shells, p. 421.

‡ See Professor Ramsay's work on the Glaciers of Wales, in the contributions of the Alpine Club.

Order 3.—CARNIVORA.

Flesh-eating animals.

Beasts of prey, as the Carnivora are sometimes called, are divided into three groups, according to the structure of their feet:—

1. Digitigrada (toe-walkers)—lion, wolf, hyena, weasel.
2. Plantigrada (flat-soled walkers)—bear, racoon, badger.
3. Pinnigrada (fin-footed)—seal, morse.

1. Digitigrada.—It is well for the tyro to become acquainted with the structure of a carnivorous jaw, and to study its adaptation for the destruction of other animals. We recommend, as a first step, a knowledge of teeth, and the difference between incisors, canines, and molars. This may seem a simple recommendation, but as I have known the jaw of a boar labelled as that of a wolf, it may not be altogether unnecessary.

An examination of the dentition of the Norway wolf and the brown hyena will convince the observer that those animals were never intended to associate with lambs. If this be a law and truth of the Creator's established now, it was also a truth millions of ages ago.

It is well also for the student of Natural History to take every opportunity of examining living forms of animals, and their prepared skeletons. The writer of these Notes has received great advantage from occasional visits to London, and a few days' quiet reflection in the British Museum, the Museum of the Royal College of Surgeons, and the Gardens of the Zoological Society of London, with the admirable "Guide to the Gardens" by the late and present secretaries to the Society for his direction. Few persons have the requisite opportunities for examination into the minutiæ and details of Comparative Anatomy, Palæontology, or other branches of the Science of Nature; but most of us have opportunities of becoming acquainted with the principles of such knowledge, if we make the most of our opportunities.

Living examples of the Digitigrada (toe-walkers) Carnivora may be seen in the cages of these animals in the Regent's Park—the house of the great Carnivora. Here are splendid specimens of the Lions of Asia and Africa (*Felis Leo*); the Tiger (*Felis Tigris*), now purely Asiatic in its range; Leopards from Africa and Asia; the Puma (*Felis concolor*), called "the Lion" of South America; and the "American Tiger," the savage and powerful Jaguar. Those who have seen the fossil relics of our English caves, the bone-caves of the geologist, will look with interest at the Hyenas, when they remember that thousands of these animals have left their remains, and that they were formerly denizens of *Great Britain*. In Regent's Park there is a specimen of the Brown Hyena, which, Mr. Sclater informs us, is a rare animal in collections, and the only one which has ever been brought alive to England.

2. PLANTIGRADA.—Bears, Racoons, Badgers, and Gluttons, place the sole of their feet flatly on the ground, and are therefore termed Plantigrades. Badgers will probably soon become extinct in Great Britain. They were once abundant in England, especially in the neighbourhood of Red Marley, Worcestershire.

Specimens of all these animals may be seen in the Zoological Gardens. There are Bears of Europe, Syria, Thibet, and America; and the grand Polar Bear (*Thalassarctos maritimus*). Of this animal Mr. Sclater writes as follows:—

> "The Polar Bear, or Ice Bear, attains probably to the largest size of all this group, for Captain Lyon records the capture of one which measured eight feet seven and a half inches in extreme length, and weighed 1600 pounds. The female has now

lived in the menagerie upwards of eleven years; the male was obtained in October, 1850. When standing on his hind legs. he can reach to the height of ten feet six inches with his muzzle. To capture an animal of this dimension, and incarcerate him without injury in a cask not exceeding five feet six inches in length, in which he lived for at least three months, and in which he was ultimately conveyed to the gardens, is a feat which few men would accomplish but the intrepid pursuers of the whale, by whom polar bears are generally brought home as a supplemental venture on their return from the Northern Seas to Peterhead."

Specimens of the Racoon (*Procyon lotor*) of North America, and an allied species — the Crab-eating Racoon (*P. cancirvorus*); also of the Glutton of Northern Europe (*Gulo arcticus*), are to be seen in the "Small Mammalia House."

As far back, in pre-existing ages, as the middle of the Secondary epoch, there were insectivorous Mammals; and in the Miocene epoch there lived, says Professor Owen, "in England and continental Europe, a peculiarly destructive feline quadruped, with the upper canines much elongated, trenchant, sharp-pointed, sabre-shaped; it was represented by species as large as a lion, and by others of the size of a leopard." These destructive carnivores lived on to the later Tertiary epochs, were the contemporaries of the gigantic cave bear and hyena, and the slayers of extinct oxen and deer in ancient England. Animals allied to the dog and fox have been found fossil, and a species of hyena was very numerous formerly in England. The caves of Devonshire and Somersetshire were tenanted by successive generations of hyenas, as is testified by their peculiar relics of fossil dung. Huge carnivores must have swarmed in Great Britain during the Mammoth period, and now the only representative of the dog tribe is the fox, of the tiger and lion the wild cat, and of the bear the badger.

The remains of a gigantic bear (*Ursus spelæus*) have been found in England, in the caves and alluvia of the Pleistocene period, as also another species (*U. priscus*). Both these species are now extinct. The perfect skull of a bear, probably that of the Brown bear (*Ursus arctos*), from a peat bog in the vale of Annan, is in the museum of Sir William Jardine. The bear has not been long extinct in Scotland.

Seals have been found fossil, and also of late, I believe, there have been discovered relics of the Walrus in the Arctic regions. The jaws and teeth of the extinct carnivores are generally so well preserved that no one, save persons with diseased imaginations, can look at them and not be convinced that they were the handiworks of the Creator—startling evidences of design, and witnesses of the truth that, from the beginning, He who created life also instituted death.

3. PINNIGRADA.—The Pinnigrade (fin-footed) Seal (*Phoca vitulina*) has a pond to itself in the gardens, where a crowd may be generally seen admiring the docility of the animal. The great Walrus is, like the Seal, a fin-footed carnivorous Mammal.

Order 4.—ARTIODACTYLA.

Even-toed animals (two or four).

This order is divided into two families:—

1. NON-RUMINANTIA (not chewers of the cud)—hippopotamus, pig, anoplotherium.
2. RUMINANTIA (chewers of the cud)—deer, ox, goat, camel, sheep.

1. NON-RUMINANTIA.—The pig is the existing representative of a very ancient race of mammals, which lived and died upon this earth long before

there were Christians to devour, or Jews to abhor, their flesh.

The same species of wild boar that was hunted by our forefathers was contemporary with the mammoth, the cave-bear, and the long-haired rhinoceros. Some persons imagine that geology deals only with fossil shells or fishes; but there is a vast deal of interest attached to the geological history of the predecessors and representatives of our domestic animals. We know that the wild ancestor of our domestic pigs was in existence before the separation of England from the continent of Europe; and that the hunter, had hunters then lived, might have chased the boar through forests, the site of which is now occupied by the waves of the English Channel. Mammoths, tigers, and rhinoceroses perished, but the wild boar lived, and lives still, on the continent of Europe, though extinct here. Our wild boar had his representative in the extinct Chœropotamus during the Dawn epoch.

The "Swine House," in the Zoological Gardens of Regent's Park, contains numerous living specimens of the Suidæ, or Swine family. The Wart hog (*Phacochœrus Æthiopicus*), two or three species of which are found in Africa; and the Peccary, an American species of hog, are very singular forms of the swine family.

The Hippopotamus Houses of the Society contain a pair of these extraordinary animals, now confined to Africa, although formerly abundant in Europe.

The following account of the capture of the older of the two is highly interesting:—

"In the month of July, 1849, a party of hunters, specially organized for the purpose, succeeded in capturing a calf of some three days old on the island of Obaysch, in the White Nile. When found in the reedy covert to which the mother had confined him, the hippopotamus, who now weighs at least four tons, was of such small dimensions that the chief huntsman took him up in his arms to carry him to the boat from which his men had landed. Covered, however, with a coat of slime more slippery than that of any fish, the calf glided from his grasp, and struggled to regain the safe recesses of the river. Quicker than he, the hunter used the gaff-hook fastened to his spear—of the same model as that used for a like purpose at the mouth of the Nile 3000 years before,—and struck him on the side, where a scar still marks the wound, and safely held him.

"From Obaysch, many hundred miles above Cairo, the hippopotamus travelled down in charge of the hunters and a company of infantry, who finally landed him at the British Agency in the month of November, 1849.

"By the obliging and liberal co-operation of the Peninsular and Oriental Company, an apparatus was constructed on board their steamer the *Ripon*, by which the peculiar requirements of the animal were perfectly accommodated, and the result was, as anticipated, that on the 25th of May, 1850, the first living hippopotamus, *since the tertiary epoch*, was landed on English soil. A special train conveyed him to London ; every station yielding up its wondering crowd to look upon the monster as he passed—fruitlessly, for they only saw the Arab keeper, who then attended him night and day, and who, for want of air, was constrained to put his head out through the roof."*

The Hippopotamus lived in England to the (geologically speaking) late date of our lacustrine and fluviatile deposits. When the Avon and Severn flowed through chains of lakes now silted up and forming the "Hams," the hippopotamus lived upon the shores. Specimens of the teeth and jaws were obtained by Mr. Strickland and the Rev. W. Parker from the lacustrine deposits of Bricklehampton and Cropthorne, near Pershore, associated with great numbers of fresh-water shells, as Limnæa, Cyclas, and Unio, of the same species as those living in the Avon.† The hippopotamus is first met with in pliocene strata; therefore is not of so ancient a family as the hog, for a true boar is found in miocene deposits.

The Anoplotherium (a beast without weapons) is an extinct genus of quadrupeds, which were allied to the hippopotamus and pig, though distantly. There are several species found fossil in the Paris Tertiaries, varying from the size of a hare to that of a fallow deer. The remains of these animals are found in strata as old as the Eocene, or Dawn epoch.

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* "Guide to the Gardens of the Zoological Society of London," by D. W. Mitchell and P. L. Sclater.

† Specimens of the teeth, &c., are in the Museum at Worcester.

2. Ruminantia.—The chewers of the cud are, of all animals, those which are the most useful to man. It is evident that the teeth of the ox were designed for the mastication of vegetables, and not for seizing other animals and tearing flesh. There are also various other modifications in the framework, such as the horny hoof instead of powerful retractile claws.

Every young palæontologist should become acquainted with the differences between the palæontological characters of a Ruminant and a Feline Carnivore as portrayed by Professor Owen.*

The Bison of America and the Aurochs of Europe were formerly among the specimens in Regent's Park, but they are now dead, and a small pair of Brahmin bulls (*Bos Zebu*) are the occupants of the "Bison House." But the Ruminants are well represented. There are many Antelopes distributed in various parts of the establishment. The Nylgau, one of the most striking antelopes, is the largest of the Asiatic species; and there are various species of Deer, among them the magnificent Wapiti of America (*Cervus Canadensis*), with the Brindled Gnu (*Catoblepas Gorgon*), in the well-stored deer-houses. We have also the privilege of beholding a splendid collection of Giraffes, several of which were born in the gardens. The parent giraffes were taken by M. Thibaut in the south-west of Kordofan, with the aid of a party of Arab hunters. The difficulty of the capture was considerable. The account of the butchery of these beautiful and inoffensive creatures by Mr. Gordon Cumming makes one sorrowful. The Eland (*Oryx leucoryx*) is a beautiful beast, and we learn from Mr. Sclater that this animal is likely to become valuable in an economic and gastronomic point of view. "The eland breeds readily in confinement; and there is every probability that in a few years this noble animal will be a permanent inhabitant of many parks in the United Kingdom."

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* Palæontology, p. 378, &c.

Both the known species of the genus Camelus, the common Camel (*Camelus dromedarius*), and the Bactrian Camel (*Camelus Bactrianus*) are to be seen in the Camel House of the Gardens; and the Zoological Society possesses three species of Wild Sheep and two of Wild Goats, several of which have reproduced in the Gardens.

A species of aboriginal British ox, with very short horns and long-fronted head (*Bos longifrons*) was co-existent with the ancient Britons, and believed to be the progenitor of our domesticated cattle. The remains of this animal are associated with the bones of the hippopotamus in the ancient deposits of the Avon. A gigantic ox (*Bos primigenius*) once roamed throughout England. Mr. Strickland, of Apperley Court, possesses a fine head of this species, and also of a large species of Bison (*Bison priscus*), from the ancient lake beds of Cropthorne, Worcestershire. They were discovered by his lamented son, the distinguished Hugh Strickland. These animals lived in those periods which pass upwards, as it were, into the present or historic epoch, and are termed Pleistocene. As far as I know, remains of sheep have not been detected in beds of earlier date than the Pleistocene deposits.*

Most of the existing species of deer are, however, pigmies when compared with some species that have become extinct. The antlers of the reindeer (*Cervus tarandus*) are small compared with those of the

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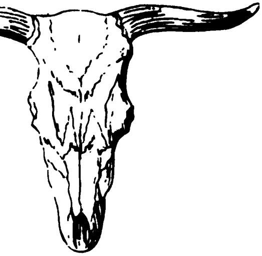
* See Roberts's "Rocks of Worcestershire," p. 233, for information on mammalian bones in the Worcestershire drifts.

PLATE

BOS PRIMIGENIUS.



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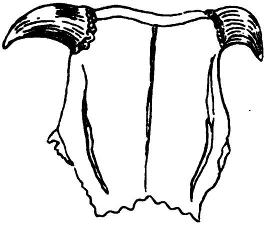
BOS LONGIFRONS.



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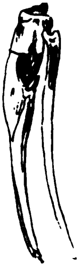
ANT-EATER'S HEAD



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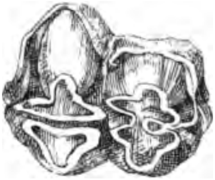
MOLAR OF HIPPOPOTAMUS.



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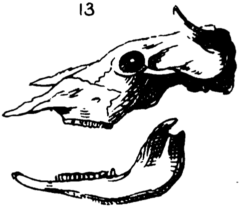
HEAD OF OX.



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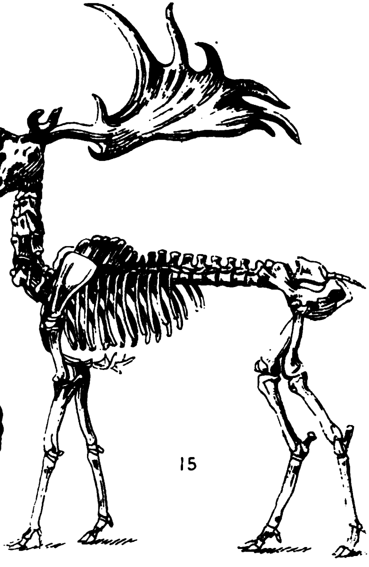

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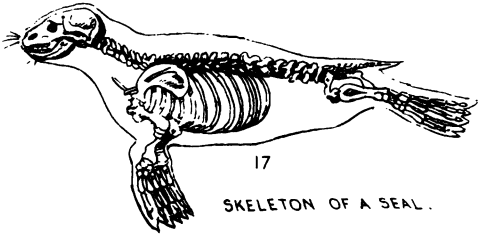
THE IRISH ELK.

16

R OF PIG.



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SKELETON OF A SEAL.

gigantic "Irish elk" (*Megaceros Hibernicus*), which was formerly very abundant in Ireland and the Isle of Man. Its remains have also been found in England. The remains of this great Irish deer (*Megaceros*) are first found in the Red crag; it lived through the long Glacial epoch, was the contemporary of the mammoth and the long-haired rhinoceros, while it is not improbable that a pre-historic human race slew the last of these noble deer. We learn from Professor Owen that this animal was a true deer, not an "elk," and "intermediate between the fallow and reindeer." The Earl of Enniskillen possesses some magnificent heads and one entire skeleton of this animal. Portions of antlers of different species of deer are abundant in the drifts and old lake beds of all parts of England. I possess a fine antler of the existing red deer (*C. Elaphus*) which, overlaid by thirty-seven feet of alluvial Severn silt, was disinterred at the great dock works of the Severn Navigation Company at Tewkesbury. The earliest known ruminant animals have been found in Miocene deposits in France. They differ widely from any living form; and it is a remarkable fact, that Professor Owen has determined that the Anoplotherium, an animal of the Dawn epoch (the Eocene), resembled in several particulars the embryo ruminant, but that the true ruminant with cloven feet and ruminating stomach did not appear until a later period in the tertiary series.

Order 5.—PERISSODACTYLA.

Odd-toed animals (one or three).

This order is divided into two families:—

1. **Solipedia** (solid-hoofed)—horse.
2. **Pachydermata** (thick-skinned) — rhinoceros, tapir, hyrax.

1. Solipedia.—The ancient appellation "soliped," means whole-hoofed, and applies to the equine genus, a family of quadrupeds so useful to man, that it was formerly supposed horses and asses were created especially for man's purposes. We now know that there were antetypes and representatives, in bygone epochs, of the common horse.

When the Spaniards discovered America, no horse was in existence throughout the length and breadth of that vast continent; but, being introduced, it has run wild, and in South America abounds in large herds. Yet America had formerly a horse which became extinct before the days of the Incas and Indians, and the remains of which are imbedded with enormous American sloths, armadillos, and other animals, which are also themselves extinct, although the shells that were their contemporaries are still living. A representative of the horse (Architherium) lived in the Dawn period, and there were some extraordinary forms,—one called Hipparion, a three-hoofed horse, and another a beast between the horse and rhinoceros (Elasmotherium), which lived in the days of those Miocene tertiaries, when volcanic action was rife in the north of Ireland and west of Scotland, and in the plains of central France.

2. Pachydermata.—Cuvier ranked the pachyderms, or thick-skinned animals, and the ruminants

as the two most distinct orders of animals. The later researches of the geologist and palæontologist furnish us with striking illustrations on the affinities of extinct species to living forms of animals.

Mr. Darwin says, and truly, that "the more ancient any form is, the more, as a general rule, it differs from living forms," and "that the extinct forms of life help to fill up the wide intervals between existing genera, families, and orders."

Professor Owen's discoveries obliged him to alter Baron Cuvier's classification of the ruminants and pachyderms. Cuvier ranked the pig as a pachyderm; but Owen discovered so many fossil links, so many intermediate animals, that he was enabled to fill up, as it were, by fine gradations, the apparently wide interval between the pig and the camel, and he tells us that a vast assemblage of species of beasts, nearly all of which have passed away, filled the interval between the ruminants and pachyderms, and coexisted in Europe with the now exotic genera of elephant, rhinoceros, and hippopotamus.

The rhinoceros is a pachyderm, as also is the tapir. A living specimen of the rhinoceros (*R. unicornis*) may be seen in Regent's Park.

The antetype of the rhinoceros was the Palæotherium, a genus which lived during the Eocene epoch, and whose remains are abundant in France. It also inhabited England, and has been found in the Binstead quarries of the Isle of Wight. Like the rhinoceros, the Palæothere frequented the borders of lakes and marshes. Some extinct species of the rhinoceros lived in the Pliocene period, and an extraordinary form of this quadruped inhabited England during the Glacial epoch. Like the mammoth, it was furnished with a twofold covering of wool and shaggy hair. An entire fossil carcase of this rhinoceros was found by Pallas in frozen soil near Yakutsk, in Siberia; and its remains have also been disinterred in large quantities near London. This is named *Rhinoceros tichorrhinus*, or strongly-walled about the nose, in contradistinction to another species of Southern Europe called *R. leptorhinus*, or fine-nosed. Mr. Hugh Strickland, Mr. Jabez Allies, and the Rev. W. Parker obtained many teeth of the rhinoceros from the Bricklehampton and Cropthorne drifts of Worcestershire.*

The Coney of the Bible is the Hyrax of naturalists, and is a diminutive hornless rhinoceros, about the size of a rabbit: it inhabits rocky places in Africa. Ancient as is the coney of Scripture, there was one still older, for a hornless rhinoceros (Acerotherium), or gigantic hyrax, lived in the Miocene period.

The Zoological Society possesses specimens of the American and Malayan species of tapir.

The tapir is a form of pachyderm, of which three species are known to be living—the Malay tapir and two American species. Many tapir-like animals, with a short proboscis, lived at the commencement of the Dawn epoch; they appear to have had affinities to the tapir and rhinoceros. The restoration of the tapir-like creatures Palæotherium and Anoplotherium by Baron Cuvier was a wondrous triumph of science.

Order 6.—PROBOSCIDEA.

Animals with a proboscis.

There are two living species of Elephants, the Asiatic and African species; they differ in the size of their ears and the structure of their teeth. Thanks

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* I have to thank Mr. Ballard, the contractor of the Malvern, Worcester, and Hereford Railway, for an interesting collection of fossil bones of the rhinoceros, elephant, and ox from the Glacial drifts of the Malvern district.

Bavaria. The skulls, teeth, a large portion of the skeletons, and even a part of the external covering of the body, consisting of wedge-shaped scales, of two other reptiles, were preserved in the carboniferous clay of the coalfield of Saarbrüch, and were described by Professor Goldfuss, under the name of Archegosaurus (primeval lizard), in 1847. Had any person ventured to prophesy, thirty years ago, that reptilian animals would be discovered in the Coal formation, he would have been set down as a heretic!

Some animals present us with organization so intermediate as to make it difficult to determine to which class of animals they belong.

The existing Lepidosiren, a specimen of which may be seen at the Crystal Palace at Sydenham, is an example. For some time naturalists were puzzled to determine whether this animal was a reptile, a fish, or an intermediate animal.

During the epoch of the Old Red sandstone, numerous ganoid, or shining-scaled fishes, frequented the ancient seas; but it is not until the Carboniferous period,* which succeeds that of the Old Red, that we meet with the Primeval Lizard. It is therefore most interesting and important to know what relation the Archegosaurus bore, first to fishes, secondly to the Old Red fishes, and thirdly to the existing reptilian class. These are the *points* interesting to the naturalist.

The remains of the Archegosaurus were referred by no less an authority than Professor Agassiz to the class of fishes (*Pygopterus Lucius*, Agassiz); and it is impossible to read Professor Owen's description of this [illegible] reptile without believing that the Archegosaurus was created after the type of the Old Red [illegible].

The vertebral column of the Archegosaurus pre-

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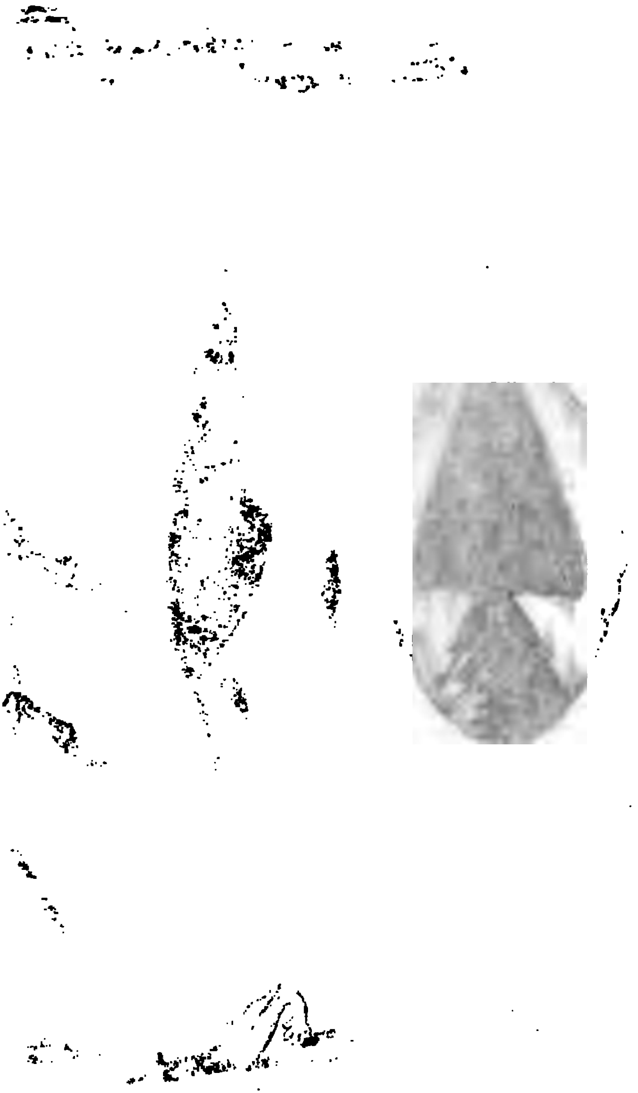
* The Elgin sandstones, that furnished the Telerpeton, are now generally considered to be of Triassic age.



IDEAL OUTLINE OF A LABYRINTHODON.

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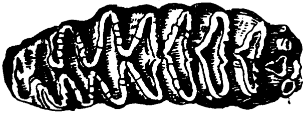

MOLAR OF AFRICAN ELEPHANT.

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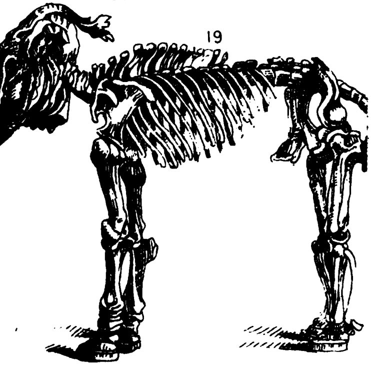

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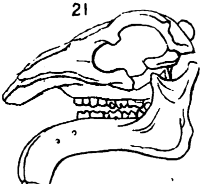

SKULL OF DINOTHERIUM.

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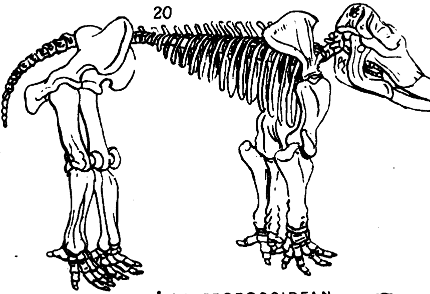
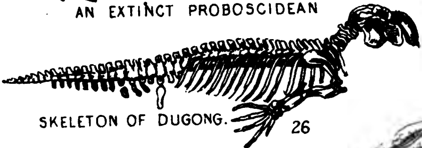


AN EXTINCT PROBOSCIDEAN

22

MOLAR OF ASIATIC ELEPHANT.



SKELETON OF DUGONG.

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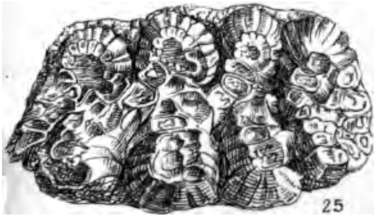

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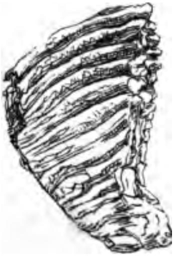
MOLAR OF MASTODON



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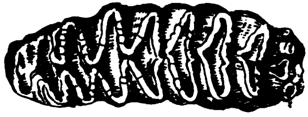

MOLAR OF AFRICAN ELEPHANT

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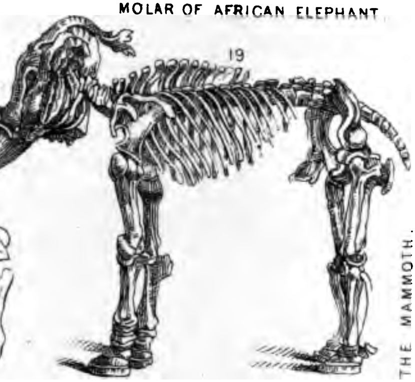

THE MAMMOTH.

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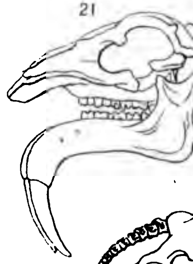

SKULL OF DINOTHERIUM.

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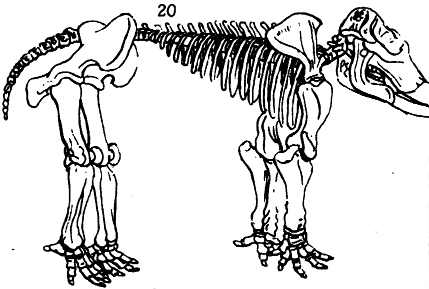

AN EXTINCT PROBOSCIDEAN

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MOLAR OF ASIATIC ELEPHANT.

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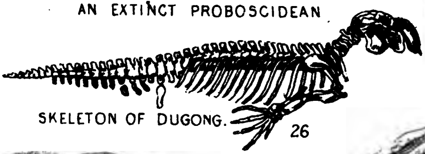

SKELETON OF DUGONG. 26

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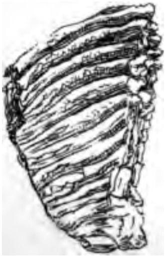
'LAR OF MASTODON



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to the travelling menagerie and the Zoological Gardens, the majestic and intelligent elephant is known to every child; but many persons are ignorant of the history of the proboscis-bearing animals of former ages. There is not, I believe, a county in England in which their fossil remains have not been found. At Ramsgate there is a collection of tusks which became entangled in the nets of fishermen off the mouth of the Thames, while near Brighton is an "elephant bed" containing the remains of hundreds of extinct elephants, of every size and age; and we are almost as sure of finding portions of the teeth or bones of the mammoth (*E. primigenius*) in Glacial gravel or drift as we are of finding the remains of extinct reptiles in the lias.

The Mammoth is the latest form of elephant which inhabited these latitudes, and ranged as far north as 60°. So abundant are their remains in Siberia, that large quantities of ivory are supplied from their tusks in these frozen charnel-houses of the far north. The perfect skeleton of one of these beasts is preserved at St. Petersburg. The carcase was found entire in frozen gravel, with its skin clothed with reddish wool and long black hair, the tusks being nearly ten feet in length; and portions of birch, willow, and fir, which it had devoured before its entombment in its icy grave, were found in its stomach.

The Mastodon was a large proboscidean with the feet, tusks, and trunk of the elephant; but the teeth were more like those of the hippopotamus, and the tusks were nearly straight, whereas those of the mammoth are curved. The mastodon inhabited America until a late geological epoch, and possibly was contemporary with man. Its remains are found in great numbers in all parts of North America, and more especially at Big-bone Lick, a celebrated morass or bog in Kentucky, about twenty-three miles in a south-west direction from Cincinnati. Imbedded in the blue clay of this ancient creek, the entire skeletons, or separate bones, of not less than 100 mastodons, 20 mammoths, with remains of a species of stag, horse, and bison, have been discovered. Different species of the mastodon once lived in Europe, and the teeth of one (*M. angustidens*), tinged with copper and heated, have furnished many a lady fair with the beautiful gem known as the turquoise. The mastodon is the oldest known form of elephantoid animal, one species having been found in strata of Miocene age.

Order 7.—**TOXODONTIA.***

The Toxodon is an extinct genus of South American mammals, three species of which have been found in recent tertiary deposits. The remains of the toxodon have only been found in South America. It was probably allied to the Sirenia.

Order 8.—**SIRENIA.**

Mermaid animals.

These animals are little known. The name is given to the group from the mermaid appearance that they present when swimming in the water nursing their children, which they hold encircled by one arm. Their appearance, however, out of the water is far from ladylike, as they look very like a seal endeavouring to be developed into an hippopotamus.

Two species of the Manatee are known in America, and the Dugong is common in Ceylon. An arctic form of the sirenia,—the Rytina, is supposed to have become extinct within the last century. It was a large animal, measuring 25 feet in length and nearly 20 in circumference. It was discovered in the year 1741, on an island in Behring's Straits. Like the great pigeon of the Mauritius,—the Dodo, the Rytina appears to have been entirely extirpated in a few years by the hand of man.

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* See Darwin's "Naturalist's Voyage."

The Sirenia, though now so small a group of animals, were once very abundant, and widely distributed throughout Europe, especially during the *Miocene* epoch.

The great Dinotherium (dreadful beast), a beast furnished with large tusks turned downwards like those of the walrus, but fixed to the lower jaws, possibly belonged to the Sirenia. The entire skull and lower jaws of the Dinotherium were discovered in miocene sand in Germany. It occurs also in India, in strata of the same age, and was found in Perim Island, in the Gulf of Cambay. This animal inhabited the embouchures of great rivers, and used the enormous tusks of the lower jaw for uprooting aquatic plants on which it fed.

Order 9.—CETACEA.

Whale-form animals.

The fish-form mammals are aquatic, and some of them are of enormous size and singular form.

The huge Rorqual is known to attain the length of 120 feet, and an American ship (the *Essex*) was destroyed by a furious cachalot. The formation of the dolphin's brain is so remarkable, and indicates so much intelligence, that the author of the "Vestiges of Creation" fixes on the dolphin as the sea-inhabiting progenitor of the monkey family, and, through the monkeys, of man. The dolphins are of ancient and time-honoured family, for three or four species have left their remains in the *Miocene* deposits.

I do not know a more wonderful history in all the records of geology than that furnished by the relics of fossil whales. In the Red crag, a pliocene deposit in Suffolk and Essex, are found vast numbers of curiously-shaped stones, which contain a large proportion of phosphate of lime. Thousands of pounds' worth of these phosphates are sold annually; thousands of tons are used in promoting the fertility of the land; and thousands of sheep and oxen are fatted upon the turnips and roots which have fed upon the phosphates. And what are, then, those life-giving stones? They are portions of the skeletons, principally the teeth, ribs, vertebræ, and ear-bones, of extinct whales, which once inhabited pliocene seas. The same phosphatic deposits are found in the Green sand and Lias, and, under the name of coprolites, are used as artificial manures. The preserved vegetation of primeval forests enhances the majesty of England by the fossil fuel stored in the bosom of the earth; and these phosphatic deposits, first pointed out by the Rev. Professor Henslow,—these relics of whales and other animals long since extinct,—have been the means of immensely developing agricultural wealth and agricultural produce.

An enormous carnivorous fossil whale, the Zeuglodon (yoke-tooth), has been found whole in Miocene deposits in America. The entire skeleton is 70 feet in length.

Order 10.—CHEIROPTERA.

Hand-winged animals.

Mr. Bell, in his work on British Quadrupeds, enumerates nineteen species of hand-winged mammalia or bats.

Bats are divided into two families, the frugivorous and insectivorous—fruit-eaters and insect-eaters. The molar teeth of the vegetable-feeders resemble those of the monkeys, and the teeth of the insectivorous bats resemble those of the insectivorous shrews and moles.

I mentioned that the winged lemur (Galeopithecus) was formerly arranged with the bats. The Galeopithecus is one of those animals selected by Mr. Darwin, in his remarkable work on "The Origin of Species," as furnishing a probable example of an animal in a transition state. Mr. Darwin cannot see any insuperable difficulty in believing it possible that "the membrane-connected fingers and forearm of the Galeopithecus might be greatly lengthened by natural selection; and this, as far as the organs of flight are concerned, would convert it into a bat."

In reply to Mr. Darwin, we must remind our readers, that Professor Owen does not range the bat family next to the lemurs. The brain of these animals is much less developed than the brain of the preceding orders of Mammals, having no convolutions, and resembling that of the insect-eaters, in advance of which group Professor Owen has arranged them.

The largest of the bat tribe attains the length of a foot in the size of the body, with an expanse of wing exceeding five feet. This is the fruit-eating bat, known as the "Flying Fox." No frugivorous bats are known fossil, but several insectivorous species have been detected in the later tertiary deposits. One species is known to have lived in the Dawn or Eocene period. Some interesting specimens of the Java Bat (Pteropus) have been recently exhibited in London.

Order 11.—INSECTIVORA.

Insect-eating animals.

The molar teeth of these animals are evidently adapted for the crushing of the insects which they devour, being covered with sharp points. The Shrew mouse would at first sight be ranked with the common mouse, but an examination of the teeth would at once convince the observer that such a classification would be incorrect. The mouse is a rodent, provided with chisel-shaped teeth in front, or gnawers, which in the shrew are altogether absent. The greater number of this order of animals burrow in the earth, and hybernate, as the shrew, mole, and desman; but there are insect-eating animals, as the tupaia of Sumatra, and the press, furnished with good eyes, and which live like squirrels in the full light of day. The hedgehog is an insectivore, and a casual inspection of the external features of the hedgehog and porcupine would incline us to range these animals in the same order. The arrangement of the teeth, nevertheless, would soon convince us that the hedgehog belongs to the insect-eaters, and the porcupine to the gnawing animals. The hedgehog has representatives in Asia and Africa, and a species called the tanrec, a native of Madagascar, has the back protected with quills, but does not roll itself into a ball. The earliest known *insectivorous mammal* is of immense antiquity. I have seen the molars of the Microlestes (little beast of prey) which were detected by my friend Mr. Charles Moore, at Frome, in Somersetshire, in a deposit of the age of the upper New Red sandstone of this county. Amongst existing mammals, the Myrmecobius of Australia has teeth offering the nearest resemblance to these antique fossil teeth; but we learn from Professor Owen, that an extinct marsupial of the Purbeck beds

(Upper Oolite), a central secondary group of rocks, afford a still nearer resemblance in the structure of its teeth; and the Microlestes may therefore appertain to the marsupial animals rather than to the insectivores.

An insect-eating mammal, probably not a marsupial, has, however, been detected in the Purbeck rocks, which has been named Spalacotherium, or mole-beast. The family of the insectivores, whether we consider the hedgehog, shrews, or moles, are all represented by extinct fossil genera.*

Order 12.—EDENTATA.

Toothless animals.

This order of animals is divisible into four families, represented by the sloths, armadillo, ant-eaters, and the extinct megatheroids. They are characterized by the absence of teeth in the front of their jaws, and by the toothless mouths of some animals of the order, as the great ant-eater, whose head tapers to a long, narrow, toothless muzzle.

The sloth is an animal which inhabits the densely intertangled forests of South America, where hundreds of miles may be traversed by passing from one tree to another. The armadillo is confined to South America, as also is the great ant-eater.

In Regent's Park they possess—the hairy armadillo (*Dasypus villosus*); the six-banded armadillo (*Dasypus sexcinctus*).

"The armadillos are a purely South American group, of which, in a former geological period, gigantic species inhabited that continent. The activity of their movements; the great rapidity with which they excavate a path into the earth when they wish for retirement; and the perfectly complete protection afforded by their flexible armour,—render the armadillos an object of continual interest to the visitors, when the weather is sufficiently warm to tempt them from their winter repose."

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* See Pictet's Palæontology.

It is not sufficient for the naturalist to know merely the history of the animal forms and certain peculiarities of structure. It is important to understand the geographical distribution of animals, and to comprehend that in present times peculiar animals are limited to particular portions of the planet's surface.

The sloth, armadillo, and platyrhine monkeys inhabit South America, but nowhere else are they found; nor have fossil remains of any animals referable to their genera ever been discovered in the old world of Asia, Europe, and Africa. The skeletons of enormous animals, allied to the sloth, are found in the later tertiary deposits of South America. The hind limbs of both the megatherium and mylodon were made enormously strong, and the prehensile fore legs also possessed such amazing power, that the animals were able to uproot and pull down large trees. They occasionally fractured their skulls when thus engaged, with the falling trees. The bony armour of an extinct gigantic armadillo (Glyptodon) has been found nearly entire in South America, and one large edentate animal (Macrotherium) has been found in the later tertiaries of Europe. This animal, Professor Owen tells us, is allied to the Manis, an old-world form of edentate animal, of which there are four or five species, inhabiting Asia and Africa. We especially recommend the reader to Mr. Darwin's "Naturalist's Voyage," for an account of the extinct edentate animals of the new world. The museum of the College of Sugeons possesses a fine collection of nearly perfect skeletons, to which every student should endeavour to gain access.

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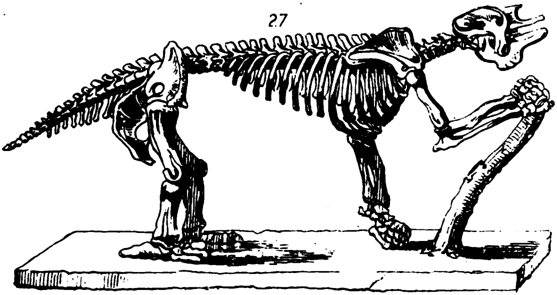

AN EXTINCT SLOTH.

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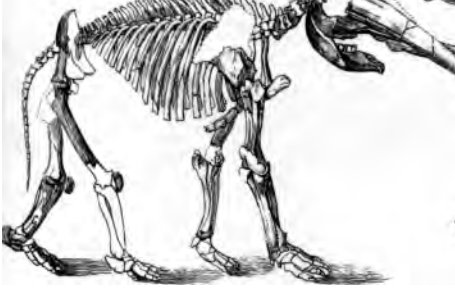

A MASTODON.

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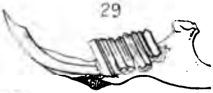
HAND OF MOLE.

29



A RODENT JAV

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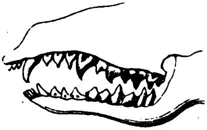
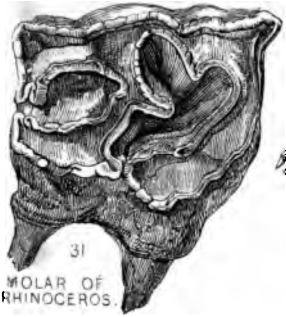


JAW OF AN INSECTIVORE.



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MOLAR OF RHINOCEROS.

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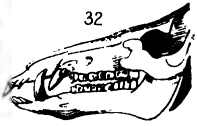

WILD BOAR.

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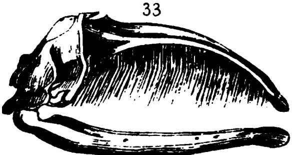

AD & WHALEBONE OF OMMON WHALE

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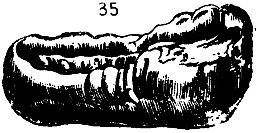
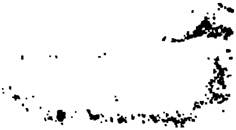


EAR BONE OF WHALE

HEAD & WHALEBONE OF COMMON WHALE.



EAR BONE OF WHALE.

Order 13.—RODENTIA.

Gnawing animals.

Squirrels, marmots, rats, rabbits, hares, hamsters, the beaver, capybara, porcupine, and several other animals similarly organized, belong to the order of gnawers or rodents.

Instead of canine teeth, they have strong chisel-shaped teeth in front and molar teeth behind. These teeth are adapted for gnawing. The brain of rodents is very like that of the insectivores. Rats and mice are well-known examples of this order, and have been transported by man to all parts of the world. They also appear, like man, to possess constitutions adapted to any climate, living as well in the torrid zones as in the far north, or the temperate parts of the world.

In "the struggle for existence," so well delineated by Mr. Darwin, in his "Origin of Species," the rat is mentioned as an example of which one species frequently takes the place of another species under the most different climates.

Mr. F. Buckland, a good authority, believes that the so-called old English rat—the black rat—is not the aboriginal rat of the British soil, but was introduced from France. At all events, the common brown rats have very nearly extirpated the black rats, once so very abundant, by the simple process of devouring their sable brethren.* The cave rat of America is undoubtedly a striking example of the effect of the use and disuse of bodily organs, as insisted on by Mr. Darwin in the modification of species.

The cave rat is blind, although the eyes are of immense size; and Mr. Darwin "attributes its loss of vision wholly to disuse." If the rat had never taken to subterranean habits, it would never have lost its eyesight.

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* Buckland's "Curiosities of Natural History."

Those who have not read Mr. Darwin's work will hardly credit that there can be any connection between cats and clover-seed, or that the one should affect the existence of the other. It is interesting, as showing "how complex and unexpected are the checks and relations between organic beings which have to struggle together in the same country." The visits of bees are, "if not indispensable, at least highly beneficial, to the fertilization of our clovers; but humble-bees alone visit the common red clover, as other bees cannot reach the nectar." If humble-bees became extinct, the red clover would become very rare or wholly disappear. Field mice destroy the combs and nests of the humble-bees, and more than two-thirds of their nests are thus destroyed. The number of mice is largely dependent upon the number of cats; and "hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district."

The common Beaver,* well known by the wonderful instinct which it displays, is a rodent. Beavers formerly lived in Great Britain, and were not extinct in Wales until after the time of Oliver Cromwell. I have seen a specimen of a beaver's head and jaw, not fossilized, which was obtained by the late Mr. Hugh Strickland from the alluvial clays of the Thames in Oxfordshire. Those who only know the rat and mouse as examples of the order rodentia will do well to purchase Routledge's "Illustrated Natural History," and thus become acquainted with the extraordinary forms of rodents so admirably illustrated and described in this excellent work.

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* A specimen of the Canadian beaver may be seen in the Zoological Gardens.

Some of the rodents are burrowing animals, and the eyes of these subterranean animals become quite rudimentary in size, and in some cases covered up and rendered useless by skin and fur. The Ctenomys of South America is a rodent, and, according to Mr. Darwin, "even more subterranean in its habits than a mole."

There is also a "ground-pig" (Aulacodus), a native of Southern Africa, which appears to be a link between the beavers and the quilled porcupines. Professor Owen informs us that no evidence has yet been obtained of any unequivocal remains of a rodent animal in strata more ancient than the Eocene tertiary deposits.

In the Zoological Garden is a cage tenanted by a fine pair of the Coypu (*Myopotamus coypus*) of South America. They are lively and playful in their habits. They are nearly allied to the Beavers (Castor), of which the Society have quite recently regained a specimen.

The Society also possesses several species of Porcupine (Hystrix) and numbers of Squirrels, the Marmot (Arctomys), the Jerboa (Dissus), with other Gnawers, may be seen in the small Mammalia house.

It is interesting to know that animals so familiar to us as our dormice and squirrels were represented in France during the Dawn period; and that "the lacustrine marls of the Miocene epoch have yielded evidences of not fewer than eleven genera of rodentia distinct from any now known to exist."

In England there lived a gigantic beaver called Trogontherium (gnawing beast), which became extinct before the historical period, and which was contemporary with a Lagomys, a tailless hare, still living in Asia, but extinct in Europe.

The Rodents of America were represented by a gigantic analogue, on that continent, during the later tertiary periods.

The Capybara, or Water-Pig, of South America, may be seen inhabiting the Beaver Pond in Regent's Park. This animal is common in the neighbourhood of all the brooks and streams of Brazil and Paraguay, feeding upon marsh and water plants and fruits. It is stated by Dr. Burmeister to be the favourite food of the Jaguar, which abounds in similar localities.

Relics of a large fossil Capybara are found in South America.

Order 14.—MARSUPIALIA.

Animals with pouches.

The pouched animals derive their name from *mnrsupium*, a pouch. There appears to be a link between the marsupials and monotremes, and also between the monotremes and birds.

Marsupials are remarkable for the premature production of their young, the young of the kangaroo being only an inch long at their birth, when they are transferred to the pouch. They are divisible into two groups—flesh-eaters, as the Opossum, Dasyurus, and Tiger-wolf (Thylacinus); and plant-eaters, as the Kangaroos, Wombat (Phascolomys), and Koala, or Australian bear (Phascolarctos).

With the exception of the opossum group of America, the marsupials are confined to Australasia and the islands of the Indian Archipelago. The comparison of animals peculiar to different zoological regions of the globe is very remarkable in the instance of the marsupialia. We are not surprised that the lion, tiger, and panther of the old world should be represented in the new world by the corresponding forms of the cougar, the jaguar, and the ocelot,or the camel by the llama; but that there should be marsupial forms of carnivores so representative as are the tiger-wolf and Tasmanian devil, of non-marsupial carnivores: or as the marsupial rodent (the wombat) is of the non-marsupial rodent, is certainly very remarkable. One cannot doubt that the Australian marsupials represent the great world of other known existing quadrupeds nearly as feebly as the wingless birds, of past ages, in New Zealand, would represent the existing creation of different birds that traverse the air, land, and waters of the globe.

It may seem strange also that marsupials should be confined, or nearly confined, to Australasia. Geology, however, steps in and tells us that it was not always so, and that the law of distribution of various classes of mammals was different in other epochs of the earth's history; that edentate animals once lived in Europe, that marsupials were once numerous in Europe, and that England possessed her marsupials ages ago. It is probable that the Microlestes of the German and English trias was an insectivorous marsupial, and also the Dromatherium of the American trias or lias deposits.

The jaws of flesh-devouring marsupials are known in the lower oolites of Stonesfield, near Oxford, associated with jaws of vegetable-feeding marsupials. In the upper oolite (the Purbeck beds) carnivorous jaws and teeth of marsupials have been detected, typical of the great tiger-wolf of Australia, the Thylacinus, which also was represented in tertiary deposits by a gigantic form of marsupial tiger-wolf. Marsupials are known to have existed through all the tertiary epochs. An opossum is associated with the remains of a monkey in the eocene strata of Suffolk.

In the structure of pouched animals there is an admirable provision for sustaining the pouch and its burden in two supplementary bones, called the marsupial bones; and with respect to these bones and their generic relations, deduced from characters of the lower jaw and teeth, Professor Owen gives a striking example of the truth of the laws of comparative anatomy.

A fossil mammal was discovered in the eocene tertiary deposits of Paris, and when Cuvier expressed his belief that it was an opossum, from the examination of the teeth and other parts, his associates doubted. "He invited them, therefore, to witness a crucial test. The outline of the back part of the pelvis was exposed, the fore-part buried in the matrix. By his delicate use of the graving-tool, Cuvier brought to light the forepart of the pelvis with the two marsupial bones."* And yet what was this triumph of science compared to that of Owen's, when he had brought to him from New Zealand what was apparently an old marrowbone, about six inches in length and rather more than two inches in thickness, and who, when he had carefully examined this unpromising fragment, ventured to prophesy that it not only belonged to a bird, but a bird that was unable to fly—a gigantic, wingless bird, far heavier than the ostrich; and prophesied truly. In the Museum of the College of Surgeons stands the skeleton of the Dinornis, and at its feet rests this old bone; and in the Transactions of the Zoological Society for 1839 are the conclusions arrived at on the old bone before the skeleton of the entire bird had arrived in England!

Many remains of marsupials, some of them belonging to gigantic animals, have been found in caves in Australia. They belong to the later tertiary epochs. When in the old world mammoths, rhinoceroses, and hippopotami — in South America gigantic sloths and armadillos—in New Zealand colossal, wingless birds were living—the forms of animal life in Australia were marsupials, and represented by gigantic kangaroos, dasyures, and wombats, rivalling in size the rhinoceros and buffalo. There is in the Worcester

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* Owen's Palæontology.

Museum a valuable collection of fossil bones of these extinct marsupials, collected by Mr. Hughes and Mr. Isaac, from Darling Downs, in Australia. They have been described by Professor Owen.

The collection of Marsupials in the Gardens of the Zoological Society of London is unrivalled, and many an hour have we passed in contemplating these ancient forms of Mammalian life.

According to the Guide to the Gardens, the Kangaroo Inclosures contain: — "Bennett's Kangaroo (*Halmaturus Bennetti*); the Pademelon Kangaroo (*H. Thetidis*); the Red-necked Kangaroo (*H. ruficollis*); the Great Kangaroo (*Macropus major*); the Black-faced Kangaroo (*M. melanops*); the Rock Kangaroo (*Petrogale penicillata*)."

"Mr. Gould asserts the excellence of kangaroo venison as a meat for the table; and the introduction of these animals would, therefore, be something more that a mere zoological luxury.

"The Great Kangaroo is now becoming scarce in the neighbourhood of the coast in New South Wales, and specimens seldom reach this country. It breeds, however, with nearly as great facility as the preceding species, and a numerous progeny has in former years been produced at the society's farms at Kingston, at Knowsley, and at Stubton in Lincolnshire."

The Wombat also may be seen in the Gardens, and of this animal it is said:—

"The natural habits of the wombat are nocturnal, and in beautiful accord with its instinct. The present specimens had no sooner been placed in the inclosure than they began to excavate a burrow under the house which had been made for their reception; and in this burrow they for a long time lived, at first showing themselves scarcely at all by day, and only coming out to feed at dusk. The wombats bred here in 1856.

"The anatomy of the wombat was described by Professor Owen in 1836, from a very large female specimen which died in the menagerie. She weighed 59½ lbs., and measured 3 feet in length. It may be observed here, that a species of wombat exists in South Australia, which is distinct from that now in the menagerie. All that is at present known of it are the deductions drawn by Professor Owen from a skull sent to him from South Australia, and figured in illustration of his essay, in the Transactions of the Society, vol. iii. p. 303. Living specimens of the wombat from South Australia would, therefore, be exceedingly acceptable. Considering how many specimens of the wombat have been brought to this country, and how easily they may be kept alive, it is not a little to be wondered at that the Koala, or Native Bear (*Phascolarctos cinereus*), which inhabits the country between Moreton Bay and Port Phillip, should still be a desideratum to the menagerie."

The Society also exhibits specimens of the Ursine Dasyure, or Tasmanian Devil (*Dasyurus ursinus*); Mauge's Dasyure (*D. Maugæi*); the Vulpine Phalanger (*Phalangista vulpina*); the Kangaroo Rat (*Hypsiprymnus murinus*); the Tasmanian Bettong (*Bettongia cuniculus*); the Short-headed Flying Opossum (*Belideus breviceps*); the Long-tailed Flying Opossum (*B. flaviventris*).

These animals all belong to the order of Marsupials, in which the young are born in a rudimentary state and transferred to a pouch situated on the lower part of the abdomen of the female.

In a cage among the birds (Eagle Aviary) is a specimen of the largest carnivorous Marsupial, the Tasmanian Wolf (Thylacinus). It is restricted to Tasmania, and has not been discovered in Australia alive. It is known there as fossil. Every naturalist should see this specimen, as the Thylacine is nearly extinct.

Order 15.—MONOTREMATA.

Only two genera of this singular class are known, the duck-billed Ornithorhynchus and the Echidna, or porcupine ant-eater. The "duck bills" frequent the Australian rivers, and are called water moles by the colonists. The Echidna is a burrowing animal, about the size of a hedgehog, furnished with strong spines like the porcupine, a tapering snout, and long flexible tongue. Its food consists of ants and other insects, caught with the tongue. It is a representative of the ant-eaters of South America.

The intestines of the Monotremes terminate, as in birds, in a cloaca, and they may be said to be almost egg-producing or oviparous beasts. They possess marsupial bones, but no marsupial pouch. The teeth are rudimentary, and altogether they appear to constitute a link between the marsupials and ovipara. These animals have not as yet been discovered in a fossil state.

These notes are necessarily very imperfect, but if they induce others to study God's works for themselves, and to commence that study by the careful perusal of the evidence adduced by such philosophers as Cuvier, Lyell, Owen, Murchison, Phillips, and Sedgwick respecting those works, the object I have had in view will be attained.

We finite men are allowed, even here below, to gather fruit within the illimitable expanse of truth, and to learn somewhat of the Creator's operations during the by-past eternity, although here we may never fully comprehend the history and its records. Truths are truths, and when they stand out before us distinct in all their teachings, encircled with the proofs of God's workmanship, I hold that we must accept them, no matter by whom they are contradicted.

There are individuals who are "colour blind," and cannot distinguish black from white or red from blue. There are, too, men who are mentally blind, and who do not, or will not, comprehend physical truths apparent to nine hundred and ninety-nine individuals out of a thousand. Such men are not to be blamed—their deficiencies are their misfortune, and not their fault; but I hold that the man who, in possession of his faculties, is mentally influenced by one mentally blind, is neither to be pitied nor excused.

Take a youth and show him your collection of animals and fossils, your fossil fish, fossil plants, fossil shells, and your tusks, teeth, and jaws of extinct elephants. Tell him that those fossils never were portions of living animals, but are stone lies; tell him that those tusks and teeth never belonged to living elephants, but were created as fossils; that the Siberian mammoth, with the hair and wool on its body, never was a mammoth, and the birch and willow in its stomach never were willow and birch, but feigned abortions, serving the purpose of "an elaborate design to deceive and not instruct,"—and if that youth believe you, depend upon it he is mentally blind. Never induce him to take up the study of God's works in bygone epochs. He may do other work, but let him leave that alone for ever. He is no more capable of entering into that history than the "colour blind" individual is of giving you a description of the golden sun, or the green leaves, or the blue firmanent. He will never understand those words of the Psalmist—"Thou takest away their breath, they die, and return to their dust. Thou sendest forth Thy spirit, they are created; and Thou renewest the face of the earth."

CHAPTER II.

CLASS II.—AVES.

Birds.

BIRDS are oviparous (egg-producing) vertebrated animals. Their skeleton is composed of nearly the same elements as in mammals, but their bones are lighter and contain more earthy matter, and are capable of being filled with air. Birds possess a wonderful double and complete circulation, with a larger amount of innate animal heat than mammals. Many birds are thus enabled to exist in the regions of ice and snow. The vision of birds is, among all living creatures, the most piercing and distinct, and therefore, as far as we know, they are examples of the most perfect adaptation of sight.

So swift are some birds upon the wing, that they exceed our utmost railroad speed in velocity; while so exquisite are the harmonious powers of others, that even woman, with " her silver tongue," cannot match their melody. Who can behold the gorgeous plumage of the birds of the tropics, the jewelled apparel of the Humming-birds, the magnificence of the Peacock, or the modest elegance of the Dove, without acknowledging that the Creator has fashioned them "beautiful exceedingly," and has bestowed upon birds wonderful gifts of intelligence, melody, beauty, power, and speed.

The individual who can pass unmoved through a collection of birds, living or dead, is unlikely to take much interest in other branches of Natural History.

> "A primrose by the water-brim,
> A yellow primrose is to him,
> And it is nothing more."

Birds are arranged in Orders, according to their structure, their distinguishing characters being chiefly taken from the formation of their legs, feet, bills, and chest-bone or sternum.

Order 1. RAPTORES (*raveners, or seizers*)—vulture, eagle, hawk, owl.

„ 2. SCANSORES (*climbers*)—woodpecker, wryneck, parrots, toucans.

„ 3. PASSERES (*sparrow-like birds*)—blackbirds, linnet, swallow, sparrow, crow.

„ 4. COLUMBÆ (*pigeons*))—pigeon, dove, dodo.

„ 5. GALLINÆ (*poultry*)—common fowl, pheasant, grouse, peacock.

„ 6. CURSORES (*runners*)—ostrich, emu, bustard, apteryx, dinornis.

„ 7. GRALLATORES (*waders*)—crane, heron, plover, rail, snipe.

„ 8. PALMIPEDES (*swimming-footed*)—divers, petrel, duck, albatross, swan.

Order 1.—RAPTORES.

Raveners, or rapacious birds.

The combined powers of flight, sight, and grasp, distinguish the rapacious birds from all others. They may be recognized by their hooked beaks and talons.

They constitute two families—the Diurnal, as the vultures and hawks; and the Nocturnal, as the owls.

The great Condor of the Andes (*Vultur gryphus*, Lin.) soars aloft, a living balloon, far above the lightest cloud, in a region so intensely cold, that were it not for the wondrous power it possesses of developing heat within its frame, it must become as adamantine as the mountain-peak above which it floats. The lammergeyer is one of the largest birds of prey of the old world. Its extent of wing sometimes reaches ten feet; and this powerful vulture has been known to hurl men and animals over the side of a precipice with a single stroke of its wing. In England, the Raptores are becoming extremely rare; even the sparrow-hawk (*Accipiter nisus*) is a rare bird. The only localities where we have seen the kite (*Milvus regalis*), within late years, are the Devil's Bridge, near Aberystwith, and on the Dryggan Mountain, between Rhyader and Llanwrytyd Wells, in South Wales. Here also may be seen the buzzard (*Buteo vulgaris*). The only time I ever saw the osprey (*Pandion haliaetos*) was at Cara Lake, near Dingle Bay, in Ireland; and only about thrice in my life, although a great rambler, have I seen, in England, the peregrine falcon (*Falco peregrinus*), blue hawk (*Strigiceps cyanus*), and merlin (*Falco æsalon*). In Great Britain these birds will soon become extinct, as have already both the great bustard (*Otis tarda*) and the little bustard (*Otis tetrax*).

No birds of the vulture tribe are found in Australia, where the absence of indigenous quadrupeds larger than the kangaroos indicate that they could not be supported on carrion. A specimen of a white hawk, sent to England, was, we have understood, the cause of Mr. Gould's visit to Australia, where he collected the materials for the most celebrated of his unsurpassed works.*

The scops-eared owl (*Strix scops*) and the little owl (*Strix passerina*, Lin.) have both been killed in Wor-

* Gould's "Birds of Australia."

cestershire, in the old forest of Wyre. They are rare British birds.

The secretary-bird (*Secretarius reptilivorus*), which possesses legs as long as a wader, is an example of the modification of structure in birds of prey. It is an inhabitant of tropical Africa, and pursues on foot the reptiles which constitute its food.

A few months ago I went to the gardens of the Zoological Society, for the sake of devoting attention to the Raptorial birds, and, thanks to the Guide, edited by Mr. Sclater, who is an accomplished ornithologist, my time was pleasantly and profitably employed.

The eagles, harpies, kites, vultures, and owls, have all their aviaries: and the variations of structure in the birds may be easily studied.

It is somewhat remarkable, that the first evidence of the existence of birds should be met with in rocks of about the same age as the oldest known mammal; viz., in rocks of the Upper Triassic period. I have already alluded to the periods of the Upper, Middle, and Lower Tertiaries, and the enormous lapses of time necessary for their fulfilment. Geologists group together vast masses of stratified deposits into a divisionary classification, which represents vastly longer epochs of time than that understood by the term period; as the Primary (or Palæozoic), Secondary, and Tertiary epochs. The great age of the first known mammal and bird may be gathered from the fact that they are known to have lived during the Triassic, the most ancient period of the Secondary epoch, which may be expressed inadequately as bearing somewhat of such proportions to the close or end of the Secondary epoch (the Cretaceous period), as the Dawn period of the Tertiaries bears to the period of existing animals and man.

Geologists are sometimes asked if they have any means of reckoning the time that has passed since the first mammal, or bird, is known to have lived and died; and to which question, the best mode of reply is by asking another.

Can the astronomer measure us off, in space, the number of inches that reckon the distance to the Nebulæ of the heavens? If so, then may we some time hope to calculate, in centuries, the millions of years that have elapsed since the rocks of the Trias were strewed in the bed of that ocean into which was swept the skeleton of the "Microlestes;" or since the sun shone upon the Triassic mud-flats of America, across which there paced birds, which left prints of their feet twenty inches in length, and one of which must have been at least "four times larger than an ostrich."

If the first found mammal is small, the "Brontozoum" was a giant among birds: and so well are some of its footsteps preserved, that "the papillose and striated characters of the integument covering the cushions on the under side of the foot"* are impressed upon the ancient mud. From the absence of teeth in birds, it is often difficult to determine their relations; but it is probable that the birds which left their footprints on the Connecticut, Triassic, or Permian sandstones, were more nearly related to the waders and aquatic birds than to the raveners, or seizers.

The generic term Lithornis (petrified bird) is applied by Professor Owen to the fossil relics of a small vulture found in the Eocene clay of the Isle of Sheppey. He also informs us, that the birds of prey were represented by species "the size of our ospreys, buzzards, and smaller falcons, and, most probably, also by an owl."

Portions of the skeletons of a vulture and a species of eagle or osprey have been found in Miocene freshwater deposits, in France, in which beds fossil eggs, and the impressions of feathers, have also been discovered.

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* Owen's Palæontology, p. 290.

The bone-caverns, which are great fissures in limestone rocks, formerly the resort of wild animals, have furnished remains closely resembling the falcon, the sparrow-hawk, and one or two species of owl.

Order 2.—SCANSORES.

Climbing birds;

The Climbers have their feet adapted for climbing, two toes being directed forwards and two backwards. There are, however, several birds that climb, the toes of which are like those of the Perchers, three before and one behind, as the tree-creepers and nuthatches. The curious honey-guides, the talking parrot, the enormously-beaked toucan, the various species of woodpecker, the wryneck, and the cuckoo, are arranged in this division.

Mr. Darwin mentions a remarkable instance of the change of habits as regards a bird of the woodpecker tribe. On the immense plains of La Plata, where not a tree grows, there is a woodpecker which never climbed a tree, but which, "in every essential part of its organization, its colouring, the harsh tone of its voice, and undulatory flight," is a true woodpecker.

The collection of parrots in Regent's Park is very rich; there are upwards of eighty species now living in the "Parrot House," from Hindostan, Java and Sumatra, Australia, Madagascar, Africa, and North and South America. Among them are also the toucan (*Ramphastus*). The beautiful grass parrakeets are in the "New Aviary;" and here again we have an example of difference of habits in the Climbers. We learn from Mr. Sclater that the grass parrakeets "for the most part inhabit the plains of the South, living almost entirely on the ground, and feeding on the seed of grasses. At certain periods of the year they migrate in vast flocks, their line being apparently determined by the scarcity or abundance of food afforded by the localities they visit. Their flight is excessively graceful; and as the tail is generally expanded in rising, the brilliant colours of the side-feathers of that organ in the Turquoisine make a most striking and attractive display."

A very remarkable genus of parrots (*Nestor hypopolius*) is restricted to New Zealand and Norfolk Island. Another species (*N. productus*), now extinct, was found living in Philip Island—so small an island, that it is only five miles in extent. So restricted was this bird, that Mr. Gould observes that persons, who have resided in Norfolk Island many years, assured him its occurrence there was totally unknown, although the distance from one island to another is not more than three or four miles. Mr. Walter Mantell discovered the fossil bones of a Nestor in alluvial soil on the western shore of the north island of New Zealand. This peculiar parrot is, therefore, of antique origin.

In the Dawn (Eocene) epoch, the Climbers were represented by species as large as the cuckoo and kingfisher, and a woodpecker has been found in Pleistocene deposits.

Order 3.—PASSERES.

Perching birds.

This is the most numerous order of the class Birds, and also the most perplexing, for it is difficult to imagine that the sparrow, shrike, crow, bird of Paradise, and the rhinoceros hornbill (Calao) belong to the same order. Yet we learn that the gradation from one genus to another is, in some instances, so

Order 4.—COLUMBÆ.

Pigeons.

Pigeons have been considered by some authors as constituting a passage from the Gallinæ, or poultry, to the Passerinæ, or perchers.

The crowned pigeon of the Indian Archipelago (*Columba coronata*) and the Nicobar pigeon (*C. nicobarica*) approximate the poultry. The former is bred in the poultry-yards of Java, and almost equals the Turkey in size.

Gnathodon strigirostris is a remarkable form of a frugivorous pigeon, which has probably become extinct within a few years. It was formerly abundant in the Samoan Island, in the Pacific, one of the Navigator group, and was exceedingly tame. Cats were let loose upon the island, and the birds are now destroyed. Sir William Jardine is in possession of the only specimen known, save one in America; the specimens procured by the North American expedition being lost at the wreck of the exploring vessel.

The variation of pigeons under domestication, as referred to by Mr. Darwin, is well worthy of earnest consideration.

Ornithologists are agreed that the numerous and well-defined breeds of domestic pigeons are descended from the common Rock pigeon (*Columba livia*), a bird which, in the wild state, builds principally in sea cliffs. The Tumblers, Runts, Barbs, and Fantails have been produced from one and the same wild species, through man's selection of pigeons, with large crops, broad tails, or ruffled necks, and by close breeding. One ot our most distinguished naturalists, nevertheless, maintains that "plasticity in a domestic condition just proves that it is unnatural and artificial; that the

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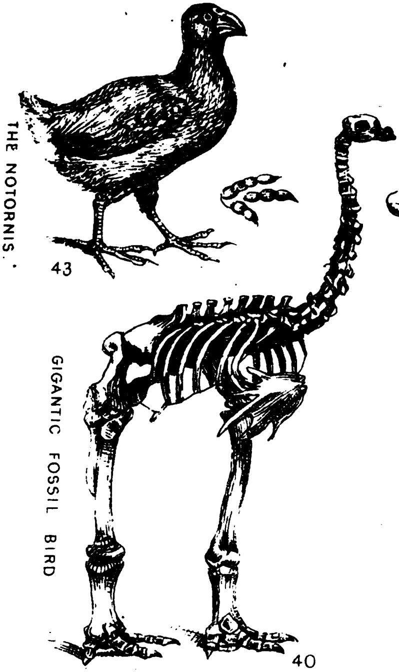
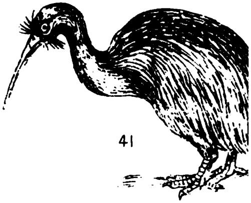

43
THE NOTORNIS.

THE DODO

40
GIGANTIC FOSSIL BIRD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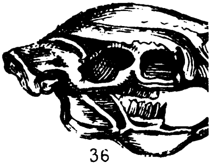
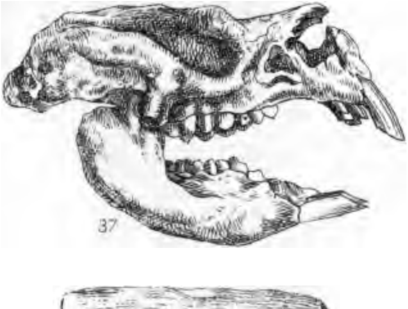

36
PORCUPINE'S SKUL


37
SKULL OF EXTINCT
GIGANTIC KANGAROO.

39
FOSSIL BIRD.

38
FOSSIL JAW OF SMALL MARSUPIAL.

PLATE

THE ARTLRY

forms desired cannot be kept up. . . . Where now among dogs is the Turnspit, the Irish bloodhound, the Spanish pointer? . . . Variation in domesticity, by crossing, is widely different from that in a state of nature, and *improved* animals, differing from anything in nature, cannot be naturally kept up. . . . God does not permit man to manufacture a *permanent* species, or to sport at will with his works; and this is proved by the fact, that none of those breeds or varieties (Mr. Darwin's incipient species) can be maintained, even with the greatest attention and care."*

Two centuries ago, the small volcanic islands of Mauritius, Rodriguez, and Bourbon were inhabited by different species of birds with wings so undeveloped that they were unable to fly. Mauritius is an island, forty miles in length, to the east of Madagascar, in the Indian Ocean, and one hundred miles from the nearest land. When discovered, it was clothed by dense forests of palms and various other trees; and when the Dutch, under Wibrant de Wanwick, took possession, in 1598, they found in the island a variety of pigeons, paroquets, and the remarkable "colossal, brevipennate, fungiverous Pigeon," the Dodo. We must refer our readers to the splendid work of Strickland and Melville for the historical and anatomical data respecting this strange bird.†

"As the Greenland whale," says Mr. Strickland, "may be called a permanent suckling, the teeth never penetrating the gums, though in youth they are distinctly traceable in the dental groove of the jaws; as the Proteus is a permanent tadpole, the Dodo was a permanent nestling, clothed with down instead of feathers, and with the wings and tail so short and feeble, to be utterly unsubservient for flight. . . . We cannot form a better idea of it than by imagining a young Duck or Gosling enlarged to the dimensions of a Swan."

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* Edinburgh New Philosophical Journal, 1860.

† The Dodo and its Kindred.

The Dodo was at first believed to belong to the Ostrich family; and Professor Owen was in favour of its affinity, though in an extremely modified form, to the Vulture; while it remained for Professor Reinhardt of Copenhagen, Strickland, and Melville, to determine its proper position "as a very aberrant member of the family Columbidæ;" and as being distantly allied to the ground pigeon (Gourinæ), some of which resemble partridges in their mode of life; and again, to the Trerons, which feed on large fruits and berries, and have strong arched beaks resembling those of the vulture. The Pezophaps (a pedestrian pigeon) was living in the island of Rodriguez in 1651, and the highly interesting account of the various productions of the island by François Leguat, who was the commander of a party of French Protestant refugees who settled there in that year, is quoted by Mr. Strickland. Bones of the Pezophaps are preserved at Paris and at Glasgow, and Dr. Melvile was enabled to determine that this bird, like the Dodo, belonged to a sub-family of the Columbidæ; and was, in short, a terrestrial, flightless, modified pigeon.

It is highly probable that in former geological ages larger islands, or a continent, occupied the geographical position where now Tromelin, Albatross, Rodriguez, Mauritius, and Bourbon islands remain as mere fragments; and that these wingless birds are, or rather were, the relics of animal life of that continent.

It is difficult to account, in any other way, for such restricted conditions of peculiar animals to such diminutive areas.

It may be said that the Dodo may have been created especially for the Mauritius island; the Pezophaps for Rodriguez (an island only fifteen miles long by six broad), and the marine lizard and black finches for the Galapagos (for, whether restricted or not, they have not hitherto been found elsewhere); but when we remember the recent history of the Rytina, confined to its island in Behring's Straits, and compare this with the known fact that this animal, or its allies, were once abundant throughout Europe; when we find that the same species of wingless birds of New Zealand are found on separate islands; I believe that it is more probable that these animals owe their restricted and peculiar positions to geographical and geological changes and conditions, rather than to their having been created for localities so restricted as Rodriguez, Mauritius, and the Galapagos. The comparative anatomist is the best judge as to the possibility of "disuse" becoming so wonderful an agent in the change of form as Mr. Darwin believes possible.

The extraordinary number of Pigeons, and their allies, may be best understood by the examination of the different forms in the British Museum. There are some beautiful living birds at the gardens of the Zoological Society, and among them the celebrated passenger pigeon (*Ectopistes migratorius*).

The following is Mr. Audubon's account of the marvellous numbers of these birds in America:—

> "In the autumn of 1813, I left my house at Henderson, on the banks of the Ohio, on my way to Louisville. In passing over the Barrens, a few miles beyond Hardensburgh, I observed the pigeons flying from north-east to south-west in greater numbers than I thought I had ever seen them before. I travelled on, and still met more, the farther I proceeded. The air was literally filled with pigeons. The light of the noonday was obscured as by an eclipse. Before sunset I reached Louisville, distant from Hardensburgh fifty-five miles. The pigeons were still passing in undiminished numbers, and continued to do so for three days in succession. . . . Let us take a column of one mile in breadth, which is far below the average size, and suppose it passing over us at the rate of one mile per minute. This will give a parallelogram of 180 miles by 1, covering 180 square miles; and allowing two pigeons to the square yard, we have 1,115,136,000 pigeons in one flock; and as every pigeon consumes fully half a pint per day, the quantity required to feed such a flock must be 8,712,000 bushels per day."

This bird, and the following, are in the New Aviary.

Twenty-one species of pigeons have been figured by Mr. Gould from Australia; and of these, there may be seen, the wonga-wonga pigeon (*Leucosarcia picata*), the bronze-wing pigeon (*Phaps chalcoptera*), and the bush bronze-wing (*Phaps elegans*). There are also specimens of the magnificent Victoria crowned pigeon (*Goura coronata*) of the Indian Archipelago.

We learn from Professor Jukes, that a true pigeon is found in Pleistocene deposits; and it appears that more are known from older beds.*

Order 5.—**GALLINÆ.**

Poultry.

This order is named after the domestic cock, Gallus. Short wings, a bony chest-bone, and a heavy carriage, are the usual characteristics ot the birds of this family, some of which are also remarkable for their gorgeous plumage. The majority of game birds belong to the Gallinæ. Several species of wild poultry are known; and one from Java is, we are informed by Sir W. Jardine, the origin of our bantams. The Argo fowl (*Phasianus giganteus*) is a native of Sumatra: this bird has been seen tall enough to peck from off a common dining-table.

The Curassows (Crax) are turkey-like birds of America, which live in the woods, feed on fruit, perch on trees, and are easily domesticated.

The common turkey was brought, not from Turkey, as is generally supposed, but from North America, in the sixteenth century. The pea-fowl was introduced into Europe from the Ganges; and the Pintado, or guinea-fowl, is indigenous to Africa.

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* Jukes's "Manual of Geology," p. 333; and Pictet's Palæontology.

I may here mention, that some years ago a guinea-fowl laid several eggs in the nest of a partridge, near my own residence; they were hatched, and four young pintados were reared with some half-dozen partridges. I requested the farmer upon whose land the birds were reared, to spare the covey, and for several months we had the pleasure of seeing a covey of wild guinea-fowl taking wing whenever the partridges rose, and accompanying them in their flight. They strayed at last, and two having been destroyed, I shot the others in the month of November, 1854. The birds were hatched in June.

In the Worcester Museum there is a remarkable hybrid between the pintado and the hen pea-fowl.

There are many varieties of the pheasant; and this bird has always been quoted as an instance of species breeding in a wild state.

The question why the improved barn-door fowl may not constitute a new species, as erected from the interbreeding and crossing of varieties descended from the jungle-fowl, is discussed ably, in the instance of the pheasant, in an article which appeared on Mr. Darwin's work, in the "Edinburgh New Philosophical Journal" for April, 1860:—

"It is argued that artificial breeds of animals would never go back to their original form: very likely not; they never would have the opportunity. The countries where they roamed are now cultivated and peopled—their ancient food and quiet destroyed; they would have no real species to mate with, and the limited variety would breed in and in as long as it could, and at last dwindle and die." Many would go back, nevertheless. The domestic pigs of New Zealand "have acquired the habits and colour of wild animals."

"The pheasant has always been quoted as an instance of two species breeding in a wild state: it is a proof of the reverse. We have not a true pheasant in all Great Britain. The ring-necked species of China, and the dark-coloured species of Persia, have both been introduced. They have been crossed and recrossed, and are altogether in an artificial state: it is well known to every sportsman that they can only be kept up by the introduction of new blood; and without this the stock would gradually be lost."

A Nepaulese pheasant is described by Dr. Hooker as living among the precipices of the Himalayas, at the height of 15,000 feet. *Ph. Reevesii*, from China, is a magnificent bird, with a tail six feet in length.

The common red grouse of sportsmen (*Lagopus Scoticus*) has long been supposed to be restricted, as a species, to Great Britain; yet we have heard the eminent ornithologist, Sir William Jardine, declare that the willow grouse (*L. saliceti*) of Norway, and the red grouse of Britain, are one and the same species, the habits being adapted to a different climate and different circumstances.

There is, in the Worcester Museum, a specimen of a hybrid between the black-cock (*Tetrao tetrix*) and the hen pheasant. The black grouse is not yet quite extinct in Wyre Forest, and stray specimens have been killed in different parts of the county.

The lover of birds may enjoy a treat among the living Gallinæ in the gardens of the Zoological Society, with the guide-book in hand, which gives a description of the most remarkable birds. The curassows are in the Old Aviary, and have bred in England. The pheasant and pea-fowl have an aviary; the gorgeous Monal is in the Impeyan pheasants' inclosure; and the strange Talegalla, or brush-turkey, which we apprehend is not a turkey, possesses an inclosure. Of this bird, the Guide says:—

"In the whole economy of the class of birds there is nothing more remarkable than the reproduction of the family to which the Talegalla, or, as the Australian colonists call it, the Bush-

Turkey, belongs. Instead of hatching their eggs by incubation in a nest, the whole of these birds, as far as their habits are yet known, construct a mound of earth, leaves, grass, sand, or other materials capable of generating and retaining heat, in which the eggs are buried by the birds and carefully watched until the young birds are matured and issue forth from the '*eccaleobion*' of Nature, stout, strong, and so fully feathered as to be capable of flight on the third day of their existence."

The American partridge, the colin, and the Californian colin, with the sand grouse (*Pterocles*), are in the New Aviary. A species of partridge is known in the Miocene deposits, and relics of several Gallinaceous birds in Pleistocene clays and caves.

Order 6.—CURSORES.

Coursers, or running birds.

The Coursers appear to have numerous affinities with the Gallinæ. The muscles of the thighs and legs are of great thickness, and their sternum is a simple buckler, without the ridge which exists in all other birds. They want the back toe, and the wings are not fully developed.

The Ostrich (Struthio) is a well-known bird, and in the sandy deserts of Africa attains the height of six feet and a half.

The ostrich is found only in Africa; and so swift is this courser, that few animals can overtake it. The American ostrich (*Rhea*), of which there are two species, is not more than half the size of the African species. The emus of New Holland represent the ostriches of the Old World, and the rheas of America. The cassowaries are found in the Moluccas.

The ostrich and bustard (*Otis tarda*) are selected by Mr. Darwin as ideal examples of the probable effect of the use and disuse of different bodily organs. He believes that the early progenitor of the ostrich had habits like those of a bustard, and that, as natural selection increased, in many successive generations, the size and weight of its body, its legs were used more and its wings less, until they became incapable of flight.

The geological history of some birds of the Courser order is very remarkable. The three islands of New Zealand appear, from the researches of geologists, to have been formerly united, and have formed one island, which was inhabited, in the later tertiary epochs, by a number of gigantic wingless birds, whose remains are now found fossil in the three islands, which must have once formed continuous land, as wingless birds are incapable of traversing across the sea. No indigenous mammals, save two bats, are known (a rat, supposed to be indigenous, was probably imported), and none have been found fossil.

The Apteryx, a singular bird, with the wings rudimentary, terminating in a little hook, and entirely obscured by the feathers, was first brought to England from New Zealand in 1812. Two species of apteryx are known as fossils. The living apteryx is nocturnal, burrowing in habits, and inhabiting densely-wooded districts. Three species at least are known.

Most extraordinary birds, allied to the ostrich order, formerly existed in New Zealand, and were the contemporaries of man, at no very remote period. These birds, we are informed by Professor Owen, resembled the apteryx; but some of them were so gigantic, that the tibia of the leg-bones of one species (*Dinornis giganteus*) measures upwards of a yard in length. The toe-bones of another (*Dinornis elephantopus*) "rival those of the elephant." The bones of some of the species indicate birds of upwards of ten feet in height. Well might they be called *terrific!* Mr. Walter Mantell has discovered remains of the eggs of the Dinornis. The eggs were much larger than those of the ostrich.

The Palapteryx (ancient—wingless) was, as its name signifies, another of these large wingless birds, a giant Apteryx, known only in a fossil state.

Investigations in Madagascar seem likely to furnish some astounding discoveries respecting birds of this order. The captain of a vessel trading to Madagascar one day observed a native using a vase which much resembled an egg, and, upon examination, proved to be one. The native eventually procured some enormous fossil eggs from the interior of the island, and some fossil bones of a bird. The largest of these eggs is equal in bulk to six ostrich-eggs, or 148 eggs of the common hen, and will hold two gallons of water.

M. St. Hilaire, who described these marvellous eggs and bones in a report to the French Académie des Sciences, proposed the name of "Æpiornis" for the monster bird that laid the monster eggs.*

The Ostrich-house in the Gardens in Regent's Park contains, the Ostrich (*Struthio camelus*), the Rhea (*Rhea Americana*), Darwin's Rhea (*Rhea Darwini*), the Emeu (*Dromæus Novæ-hollandiæ*), the Cassowary (*Casuarius galeatus*), the Mooruk (*Casuarius Bennetti*), and the Apteryx. Specimens of the Bustard may be seen in the New Aviary. The Guide remarks:—

> "The Bustards are one of the most striking and well-distinguished families of the Old World. They number about twenty-three species, of which three are European, three Indian, one Australian, and fifteen indigenous to Africa. The Houbaras are found in South-Western Europe, Africa, and India; the Little Bustard in Europe and Africa; the Great Bustard in Europe and Asia. They are extremely majestic in their carriage, even the smaller species having a certain stateliness, and showing their relationship to those noble forms of which the great Kori

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* *Athenæum*, March 22, 1851.

Bustard of South Africa is the most remarkable. This bird was among the discoveries of Dr. Burchell, whose researches in the natural history of South Africa have never yet been sufficiently appreciated beyond the immediate circle of his friends."

Order 7.—GRALLATORES.

Wading Birds.

The Great Bustard* (*Otis tarda*) is the largest of European birds, and was formerly abundant in Great Britain. A noble pair of these birds, captured in Norfolk, were presented some years ago to the Museum at Worcester by Lord Lyttelton; and about four years since, a male bustard was shot on the Wiltshire downs, in full plumage. The bustard, nevertheless, may now be considered extinct in England.

Many of the birds of this order are remarkable for the length of their legs, some of them looking as if they walked on stilts; as the Heron, and more especially the Stilt-bird (*Charadrius himantopus*). The legs of many of the family are adapted for wading in shallow water, and some, as the Jacana of America, have long toes, especially adapted for walking on the floating leaves of aquatic plants. The common Heron, Curlew, Woodcock, Coot, and Rail, are familiar examples of the Waders.

In Regent's Park there is the Waders' Inclosure. In this inclosure there are always to be found a collection of Wading birds, which includes the Godwit (*Limosa ægocephala* and *L. Lapponica*); the Spoonbill (*Platalea leucorodia*); the Avocet (*Recurvirostra avocetta*); the Ruff (*Machetes pugnax*); the Knot

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* Mr. Sclater informs me that he considers the Bustard more nearly allied to the Waders than the Coursers.

(*Tringa canutus*); the Whimbrel (*Numenius phæopus*); the Curlew (*Numenius arquatus*); the Oyster-Catcher (*Hæmatopus ostralegus*); the Coot (*Fulica atra*); the Crested Coot (*Fulica cristata*), and several other European species.

The Crane Inclosure contains several species of Cranes and Storks. Three species of the Ibis are in the New Aviary; as are also the Australian Porphyrio (*Porphyrio melanotus*), and the Weka Rail (*Ocydromus australis*), to which the geologist will pay especial attention, as the probably extinct Notornis of New Zealand is allied to the Porphyrio, and the Weka Rail follows the fashion of the wingless birds in structure.

Fossil bones of a bird of the Rail family were found by Mr. Walter Mantell, in 1847, associated with the relics of the Dinornis; and a specimen of this "Swamp Hen" (*Notornis Mantelli*) was captured alive in a remote and unfrequented part of the Middle island of New Zealand, in 1850. So little was known of this bird, even to the natives, that, when the skin was shown them by Mr. Walter Mantell, who obtained the specimen from some whalers, they declared that they had never seen such a bird, but that it was their traditional Takahé, which they had believed to be utterly extinct. Notornis means the bird of the south. Mr. Gould has published a coloured figure of the probably now extinct Notornis, which was unquestionably the contemporary of the gigantic Dinornis. It possessed bright scarlet legs and beak; the neck and body are of a dark purple colour, the wings and back being shot with green and gold.

In the Worcester Museum there are specimens of a Rail from New Zealand, presented by Mr. Robert Gale. The wings of these birds are very short and rudimentary. I imagine these are the short-winged Rails of New Zealand (*Ocydromus australis*) described by Professor Owen as a genus as characteristic of New Zealand as the Apteryx itself.

In the Dawn epoch this order of bird was represented by "a Curlew of the size of the Ibis," and by species allied to and of the size of our Woodcocks, Lapwings, and Sanderlings.

Wading birds were numerous in the succeeding Miocene epoch, many of their remains having been discovered in the Miocene lacustrine deposits of Cantal.

Professor Owen has described a large bird (*Gastornis Parisiensis*) from the Eocene Tertiaries of Paris, "with affinities to the Waders and Palmipedes, or Aquatic birds."

Order 8. — **PALMIPEDES.**

Web-footed birds.

The large webbed feet serving for oars are the great characteristics of these birds. Some, as the Penguin (*Aptenodytes*) and Great Auk (*Alca*), cannot fly; while the Frigate-bird, so unsurpassed in its power of wing, is web-footed, yet seldom, if ever, alights on the water. The position of the legs in the Divers is farther backward than in any other birds, and their wings are employed as fins. Some of these birds are nearly as aquatic as fishes, of which they are great destroyers; and the adaptation and design manifested in their structure are very remarkable. Cuvier remarks, that these are the only birds in which the neck exceeds—and sometimes considerably—the length of the legs. Swimming on the surface, they can thus dip deeper to seize their prey.

The Penguins are the most aquatic of all birds; their feathers are almost reduced into the condition of scales, and their wings to fins. The Albatross (*Diomedea*), Gulls (*Lari*), and Petrel (*Procellaria*) have long and powerful wings. The Stormy

Petrel is well known as an ocean bird, which, in the length of its wings and the swiftness of its flight, equals the Swallow. Mr. Darwin gives an extraordinary and interesting instance of modification of structure even in birds so truly aërial as the Petrels. He informs us, that there lives a Petrel, in the quiet, undisturbed Sounds of Tierra del Fuego, with many parts of its organization so modified that it flies unwillingly; while in its astonishing power of diving it might be taken for an Auk or a Grebe.

The Great Auk (*Alca impennis*) is become so extremely rare, that it may be considered as nearly extinct. This bird appears to have been a northern short-winged palmipede bird, as the Penguin is an antarctic bird.

Not so the Little Auk (*Mergulus*), for this bird exists in myriads. So abundant is it in the northern regions, that we learn from Sir Wm. Jardine, that it frequents the coast of Spitzbergen, in such amazing numbers, that nearly *four millions* have been calculated to have been seen, at one time, on the wing.*

In the Waterfowl Inclosures of the Zoological Society is a choice collection of Palmipedes. Among these are specimens of the Upland Goose, from the Falkland Islands, where they breed in great numbers. These are birds which Mr. Darwin instances as having transitional habits; "upland geese, with webbed feet, which rarely or never go near the water." The Flamingo (*Phœnicopterus*) is a bird of peculiar structure, and which has been ranked with the waders; but we learn from Sir W. Jardine, that "it is a Grallatorial duck." The Flamingo is in the Old Aviary; and is from the Mediterranean.

In clay of the Dawn epoch fossil remains of birds of the seagull and heron families have been found at Sheppy and at Highgate. Birds allied to the Pelican and Wild Duck have also been found fossil in rocks of this epoch, on the continent,* with species allied to the cormorant, and akin to the divers.

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* Jardine's "Naturalist's Library," vol. iv. p. 226.

In Pliocene deposits, the remains of the "fossil metatarsal of a swan" have been discovered, not distinguishable, says Professor Owen, from that of the existing wild swan; and in the Pleistocene clay of Lawford, a fossil humerus, like that of a wild goose. Terns, Pelicans, Ducks, and Divers have been found in the *Pleistocene* deposits; and in New Zealand there has lately been discovered, by Mr. Walter Mantell, the son of the celebrated geologist, Dr. Mantell, the fossil relics of a Penguin, in strata possibly as old as the Eocene Tertiaries.

This bird is described by Professor T. H. Huxley,† as approximating to the Crested Penguin (*Eudyptes chrysolophus*); but he cannot regard it as belonging to any known genus, and therefore has called it the Palæeudyptes (ancient Eudyptes).

The bone, described by Professor Huxley, was found by a native in the limestone of Kakauie, which limestone is overlaid by a mass of blue clay, the blue clay being itself surmounted by a bed containing freshwater shells; and upon this, again, lies the alluvium, in which the remains of the Dinornis are found.

The marine shells contained in the blue clay and in the limestone are different from those now living in the seas of New Zealand.

"Whatever," says Mr. Huxley, "be the precise age of the fossil, it is not a little remarkable to find, in strata of such antiquity, the remains of a bird, the whole of whose congeners are at present absolutely confined to the Southern Hemisphere; therefore, in a broad sense, to the same great distributional area. If the strata be of Pliocene age, the fact is in accordance with the relations which have been observed to obtain between the recent and Pliocene fauna of the Northern Hemisphere. On the other hand, the little that is at present known respecting the distribution of birds in time is not inconsistent with the ascription of a far greater antiquity to a genus as closely allied as Palæeudyptes to those which now exist."

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* Juke's "Manual of Geology," p. 833, and Pictet's Palæontology.

† Proceedings of Geological Society, Feb. 1, 1860, p. 670.

CHAPTER III.

CLASS III.—REPTILIA.

Reptiles.

Reptiles possess lungs like the Mammalia and Birds, but only a portion of their blood passes through their lungs. They are cold-blooded and have very little brain; many are carnivorous, and swallow their prey entire. Some are venomous, as the Viper and different kinds of serpents; others, as the Crocodiles, Gavials, and Alligators, are large Lizards (Saurians); and a few, as the Turtle and Tortoise, are useful for the food of man. The Tortoise, Lizard, and Serpent have very different forms, and the skeletons of reptiles present greater variation of structure than those of warm-blooded vertebrata.

Some Reptiles have the body naked, others have it covered with scales, plates, or a horny shell. Like birds, they lay eggs, which they generally abandon, and the young are hatched by the heat of the sun. The great Indian serpent Python, which sometimes attains the length of forty feet, is a remarkable exception, as this monster hatches its eggs, during which period the temperature of its own body rises considerably.

Some, as the common viper of this country, are ovoviparous, that is to say, the young are hatched before being born.

Professor Owen has prepared an elaborate classification of reptilian animals, and has arranged them in thirteen orders, of which eight are extinct, and five are both fossil and still living.* The following is a summary of the Professor's classification :—

Classes of Reptilia.	*Geological Epochs.*
1. Ganocephala (lustrous, or shining-headed reptiles)	Carboniferous.
2. Labyrinthodontia (labyrinthine-toothed reptiles)	Triassic.
3. Ichthyopterygia (fish-finned reptiles)	Lias to chalk.
4. Sauropterygia (lizard-finned reptiles)	Trias to chalk.
5. Anomodontia (tooth-wanting reptiles)	Triassic.
6. Pterosauria (winged saurians)	Lias to chalk.
7. Thecodontia (socket-toothed reptiles)	Triassic.
8. Dinosauri (terrible saurians)	Lias—greensand.
9. Crocodilia (crocodiles)	Lias to present time.
10. Lacertilia (lizards, monitors)	Oolitic to present time.
11. Ophidia (serpents, slow-worms)	Tertiary—living.
12. Chelonia (tortoises and turtles)	Trias to present time.
13. Batrachia (toads, frogs, newts)	Oolitic to present time.

Order 1.—GANOCEPHALA.

Shining-headed Reptiles.

The name of this order was assigned by Professor Owen, from the sculptured and externally polished, or ganoid bony plates with which the head was covered, and to this order the oldest known reptiles appertain. They were formerly referred to the class of fishes, until specimens were discovered in Germany, which enabled the comparative anatomist to determine the reptilian characters. We learn from Sir C. Lyell,† that the first skeleton of these ancient reptiles was announced by H. Von Meyer, in 1844, from the carboniferous rocks of Munster Appel, in Rhenish

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* Reports, British Association, 1859.

† "Manual of Elementary Geology," 5th edit., p. 400.

Bavaria. The skulls, teeth, a large portion of the skeletons, and even a part of the external covering of the body, consisting of wedge-shaped scales, of two other reptiles, were preserved in the carboniferous clay of the coalfield of Saarbrüch, and were described by Professor Goldfuss, under the name of Archegosaurus (primeval lizard), in 1847. Had any person ventured to prophesy, thirty years ago, that reptilian animals would be discovered in the Coal formation, he would have been set down as a heretic!

Some animals present us with organization so intermediate as to make it difficult to determine to which class of animals they belong.

The existing Lepidosiren, a specimen of which may be seen at the Crystal Palace at Sydenham, is an example. For some time naturalists were puzzled to determine whether this animal was a reptile, a fish, or an intermediate animal.

During the epoch of the Old Red sandstone, numerous ganoid, or shining-scaled fishes, frequented the ancient seas; but it is not until the Carboniferous period,* which succeeds that of the Old Red, that we meet with the Primeval Lizard. It is therefore most interesting and important to know what relation the Archegosaurus bore, first to fishes, secondly to the Old Red fishes, and thirdly to the existing reptilian class. These are the *points* interesting to the naturalist.

The remains of the Archegosaurus were referred by no less an authority than Professor Agassiz to the class of fishes (*Pygopterus Lucius*, Agassiz); and it is impossible to read Professor Owen's description of this old reptile without believing that the Archegosaurus was created after the type of the Old Red Ganoidal fish.

The vertebral column of the Archegosaurus pre-

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* The Elgin sandstones, that furnished the Telerpeton, are now generally believed to be of *Triassic* age.

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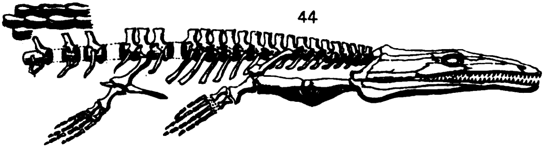

ANCIENT REPTILE FROM THE COAL.

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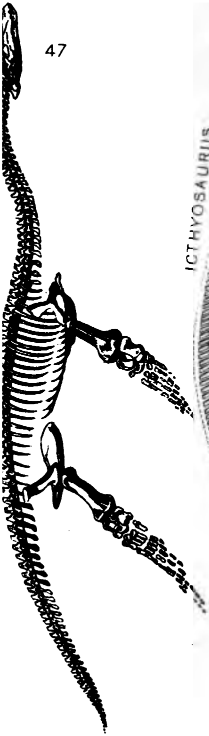

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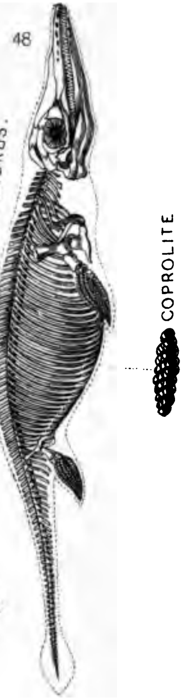

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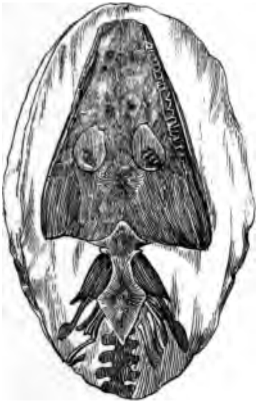

HEAD OF ARCHEGOSAURUS. FROM COAL MEASURES.

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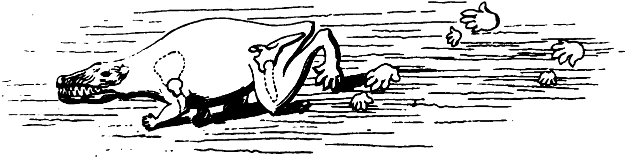

IDEAL OUTLINE OF A LABYRINTHODON.

sents an embryonal condition, and "in this structure the old carboniferous reptile resembled the existing Lepidosiren." "Both illustrate the artificiality of the supposed class distinction between fishes and reptiles." * If we rightly understand Professor Owen, the ancient Ganoidal Archegosaurus represents the march of development from the Ganoidal fish of the Old Red sandstone, into the more elaborate Labyrinthodont reptiles of the Trias; as the living Lepidosiren represents the march of development from the fish, through the batrachians (frogs), to the lower existing orders of the reptile class. Myriads of ages ago, the Archegosaurus was an animal intermediate between the fish and the reptile, possessing more of the reptilian character than the Lepidosiren, which is an intermediate animal now.

In 1852, Sir C. Lyell and Mr. Dawson obtained portions of the skeleton of a reptile from the interior of one of the great coal-plants, an erect Sigillaria, which grew on the ancient land of Nova Scotia. The shell of an air-breathing mollusk, allied to Bulimus or Pupa, had been washed into the hollow tree with the skeleton of the reptile. This is the oldest known land shell, the first air-breathing mollusk yet discovered; and is interesting as associated with the earliest of known air-breathing quadrupeds. Several of the land shells have since been detected in the Nova Scotia coal-fields. The reptile is named "Dendrerpeton" (Tree lizard), and from its close affinities to the Archegosaurus is ranked by Professor Owen in the Ganocephalous order.

The remains of another reptile (*Raniceps*) have been discovered in a seam of coal in Ohio, United States, and have been referred, by Professor Wyman, to the Batrachians.

Footprints of much larger reptiles than those of Archegosaurus or Dendrerpeton have been discovered in America by Dr. King; while, in Great Britain, footmarks of reptilian animals have been detected by Hugh Miller, Mr. Binney, and the Rev. C. Bromby. These footmarks are impressed upon ancient beaches, and associated with sun-cracks and rain-drops. The study of fossil footsteps, shrinkage-cracks, rain-marks, ripple-marks, and worm-tracks, has added much to the data of geologists. The splendid work on the Ichnology (footprints on stone) of Annandale, by Sir Wm. Jardine, is illustrative of the footprints of fossil reptiles that lived in the Permian period, which succeeded the long Carboniferous epoch, whilst the great work of Professor Hitchcock, of America, on the Ichnology of Massachusetts, should be consulted by all earnest students of geology.

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* Owen's Palæontology, p. 198.

Order 2.—LABYRINTHODONTIA.

Labyrinthine-toothed reptiles.

Professor Owen informs us that the Archegosaurus conducts the march of development from the fish proper to the Labyrinthodont type.

The Labyrinthodons were so named, by Owen, from the complex structure of their teeth. These extinct and remarkable reptiles lived during the Carboniferous epoch; for one, named Baphetes (a diver), so called from the position and shape of the head, was described, in January, 1854, by Professor Owen, from the coal-field of Pictou, Nova Scotia.

We learn also, from the comparative anatomist, that the Labyrinthodont reptiles manifested an affinity to fishes in the structure of their teeth; that in the rest of their structure they manifested characters of the lowest reptilian order, viz., the Batrachia; and that, with the characters of the Batrachia, they combine other bony characters, of crocodiles, lizards, and the ancient Ganoid fishes.*

Judging from the fossil bones and footprints, some of the Labyrinthodonts must have been of large size, and the form somewhat that of a gigantic frog. The *Labyrinthodon Jagaeri* must have been an awful creature, if we may judge from the canine teeth, and the large hand-like impressions left on the slabs of the New Red sandstone epoch.

Impressions of the feet of a Labyrinthodon were found by the late Mr. Hugh Strickland in the lower Keuper sandstone of Shrewly Common, Worcestershire; and bones and teeth have been discovered near Kenilworth, in the Permian sandstones of the geological surveyors, as well as in the upper Keuper beds, where they have been detected by the Rev. Mr. Brodie. Five species of Labyrinthodont reptiles have been found in Great Britain, all of which must, from Professor Owen's description, have been very unpleasant-looking animals, with fearful jaws, and prodigious hind limbs, adapted especially for biting and jumping. And yet such animals lived on the shores of a sea-bed which now constitutes much of the pleasant vales of Worcestershire and Cheshire, the shores of the New Red sandstone sea.

Order 3.—ICHTHYOPTERYGIA.

Fish-finned reptiles.

This order appears to retain an affinity to fishes in the structure of the fins, and several other particulars, too recondite for any but an anatomist to enter into. The Ichthyosaurus is a fish-finned reptile. Who does not know the Ichthyosaurus? Who has not seen his skeleton and grinning jaws, or wondered at the marvels of its stony eye-plates? Who has not disinterred the vertebræ, or ribs, from some lias quarry?

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* See Owen's Palæontology, p. 185, &c.

So abundant were the different species of Ichthyosaur in the neighbourhood in which I resided, during the epoch of the lias, that I do not know a lias quarry which has not afforded portions of the fossilized skeletons of these extinct reptiles. I have disinterred the greater part of the skeleton of an Ichthyosaur from the lias outlier of the Berrow Hill, within two miles of the range of the Malverns; and on the same day I have visited some half-dozen quarries, many miles apart, in all of which I have seen fragments of the "fish-finned" saurians. One bed of the lower lias might appropriately be called the Saurian's grave, so charged is it with relics of these animals.

I do not here refer to the Bone bed, which is now, owing to the researches of Sir P. Grey Egerton, ranked as the uppermost Triassic deposit, but to the Ostrea and Saurian bed of the lower Lias. It lies a few feet over the insect limestone of Brodie, and contains a greater number of the relics of Ichthyosauri, in the vale of Worcester, than all the other beds of the Lias put together. The Ichthyosaurus respired air from the atmosphere, like the whales, and not through a watery medium, like fishes. The general outline was that of a large porpoise with enormous eyes, defended by a series of overlapping plates,—a mechanism analogous to that observable in the eyes of turtles, tortoises, lizards, and birds, and which confers on the eye great power of vision as well as being a defensive apparatus to the capsule. From the bony structure connected with the fore-fins, Professor Owen concludes that the Ichthyosauri occasionally "sought the shores, crawled on the sand, and basked in the sunshine," and that "its general external figure must have been that of a huge predatory fish, scaleless, and covered by a smooth or finelywrinkled skin, analogous to that of the whale tribe." The teeth of this animal were very numerous, and abound, with broken pieces of the jaw, in the lower Lias quarries. Portions of the integuments, in a carbonized state, may also occasionally be met with. Sir Philip Egerton discovered the phalangeal bones of a paddle at Barrow-on-Soar, with the soft parts lying in their natural position; and Mr. Moore, of Bath, possesses remains of the skin in a wonderful state of preservation. The remains of fish and small reptiles are occasionally found in the stomach of the Ichthyosaurus, and the coprolites not only show the nature of the animal's food, but also bear the form of the intestinal canal, which we thus know to have been spirally convoluted, as in the corresponding organs of the Shark and Dog-fish. A coprolite which I found at Sarnhill, near Tewkesbury, has imbedded in it the humerus of a juvenile Ichthyosaur with the scales of a Lias fish.

More than thirty species of Ichthyosaurus are known. Some of them must have been gigantic, as witnessed by the remains in the British and Bristol Museums. I have seen teeth over two inches and a half in length, in the quarries of Brockeridge Common, near Upton-on-Severn, and vertebræ that measured five inches across.

The most common species was about eight or nine feet in length.

Order 4.—SAUROPTERYGIA.

Lizard-finned reptiles.

Some of the most remarkable of these proofs of the correlation of Palæontology with the Geologic record may be gathered by a perusal of Professor Owen's chapters on the Reptilia, in his work on the "Systematic Summary of Extinct Animals, and their Geological Relations."

It is very evident, from the professor's account of the Archegosaurus, that this ancient reptile was simple in structure and altogether rudimentary. Simple and rudimentary also are all the known reptiles of the Carboniferous epoch; while, no sooner do we pass the boundaries of the Carboniferous horizon, and enter upon the Permian and Triassic periods, than we find an advance in the organization of reptiles. The Permian Protorosaurus and Rhophalodon were decidedly of a higher order than any that have hitherto been discovered in the Carboniferous deposits, and Professor Owen gives a diagram of the skeleton of the Nothosaurus of the German Muschelkalk, a deposit of the New Red sandstone epoch, for comparison with that of the Archegosaurus, and to prove the advance in the organization of aquatic reptiles.

The Plesiosaurus is ranked by Owen among the lizard-finned reptiles, and the name signifies "nearly allied to a lizard." The Plesiosaurus has been discovered in a beautiful state of preservation, the entire skeleton having been petrified in the soft mud, now turned to clay, in which it was entombed. The contour of the animal is so remarkable, that it has been graphically compared to a serpent threaded through the shell of a turtle.

Baron Cuvier believed the structure of the Plesiosaurus "to have been the most singular, and its character the most anomalous, that had been discovered amid the ruins of a former world." "To the head of a lizard it united the teeth of a crocodile, a neck of enormous length, resembling the body of a serpent, a trunk and tail having the proportions of an ordinary quadruped, the ribs of a chameleon, and the paddles of a whale." We learn also, that of existing reptiles, the lizard, and amongst them, the old-world Monitors, most resemble the Plesiosaur in the structure of the skull. The Plesiosaurus ranges from the Trias (bone-bed) to the Chalk, inclusive, and some twenty species are known. They were marine animals, and their Muschelkalk predecessors "were better organized for occasional progression on dry land." The Plesiosaurus was by no means abundant during the deposition of the Lower Lias of this district. I do not know of more than half a dozen specimens of Plesiosaurian relics that have been found anywhere in Worcestershire or Gloucestershire. The vertebræ are easily known from those of the Ichthyosaur: they are longer and less concave. The teeth are conical, and more slender and pointed than those of the Ichthyosaur; they are also slightly recurved.

There are many other genera of lizard-finned reptiles; as the Pistosaurus, Pliosaurus, Simosaurus, and Polyptychodon. The Placodus (plate-toothed) is an extraordinary fish-finned reptile, found in the Muschelkalk (Trias) of Germany. The development of the teeth and jaws of this animal, as described by Owen, is indeed marvellous. "The temporal fossæ are the widest, and zygomatic arches the strongest, in the whole class Reptilia; the lower jaw presents a like excessive development of the coronoid processes. These developments, for great size and power of action of the biting and grinding muscles, relate to a most extraordinary form and size of the teeth, which resemble paving-stones, and were evidently adapted to crack and bruise shells and crusts of marine invertebrata."* Some Australian lizards of the present day possess rounded teeth, adapted for crushing hard substances, and have therefore received the generic term of Cyclodus (circle-toothed).

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* Palæontology, p. 216.

Order 5.—ANOMODONTIA.

Toothless reptiles, or reptiles with inconspicuous teeth.

Several species of an extinct order of reptiles, named Dicynodon (two tusks), have been found in **Africa** by Mr. A. G. Bain.

The singular animals presented in the construction of their skull the characters of the crocodile, the tortoise, and the lizard; but the only teeth developed were "two sharp-pointed tusks, growing downwards, one from each side of the upper jaw, like the tusks of the Mammalian Morse (*Trichecus*)." *

The Rhynchosaurus (beaked lizard) of the New Red sandstone belongs to this order, and to the Cryptodont family of Owen; so called from the animals which compose it being edentulous, or possessing inconspicuous teeth. The Rhynchosaurus has been found at Grinshill, near Shrewsbury, and I saw, some years ago, a remarkably fine specimen of the skull in the possession of a widow woman at the village of Clive. There are no teeth apparent in either jaw, and the resemblance of the mouth to the compressed beak of certain sea birds, with other peculiarities of structure, leads Professor Owen to believe that "the ancient Rhynchosaur may have had its jaws encased by a bony sheath, as in birds and turtles." Footprints of a small reptile have been obtained by Sir William Jardine from the Grinshill sandstones, and in the same slab are broken fragments of reptilian bones. These are, in all probability, the footmarks of the Rhynchosaur.

Remains of fossil plants are abundant in the Ombersley sandstones of Worcestershire, and the *Echinostachys oblongus* found by Mr. Hugh Strickland

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* Palæontology, p. 236.

PLATE 7.

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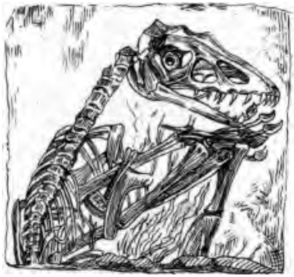
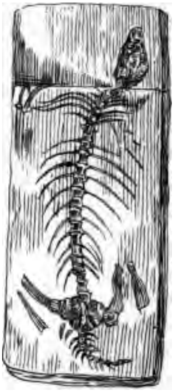


A PTEROSAUR IN STONE.

52

A GAVIAL TOOTH.



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THE TELERPETON OF THE TRIAS.

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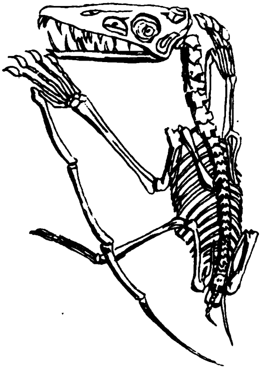
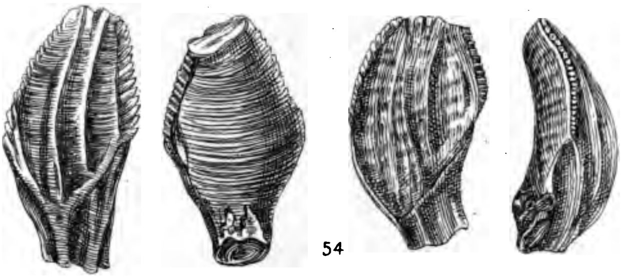


PTERODACTYLUS CRASSIROSTRIS.



54

54 TEETH OF EXTINCT VEGETABLE FEEDING REPTILE. THE IGUANODON.

was considered by Dr. Lindley to be identical with the specimens described by M. Brongniart from the "Grès bigarré."

Order 6.—PTEROSAURIA.

Winged lizards.

This group, or order of reptiles, is altogether extinct, for not one species remains. The winged reptiles have not been found previous to the Liassic epoch, and appear to have died out before the commencement of the Tertiary ages. The far-famed Pterodactyle is a Pterosaur. Its remains have been found by Mr. Brodie, in the lower lias of Gloucestershire; and bones have been detected in the coeval beds of Germany. Many species have been described. It was not merely in magnitude, observes the illustrious Cuvier, that reptiles stood pre-eminent in ancient days, but they were distinguished by forms more varied and extraordinary than any that are now known to exist on the face of the earth. "Its power of flight must have far exceeded that of the *Draco volans*, the only existing reptile that can traverse the air, and probably equalled those of the bat."* It had a long-snouted head, and long neck, with jaws armed with sharp and pointed teeth. The eye was very large; and we learn from Owen that "the weak pelvis and hind limbs bespeak a creature unable to stand and walk like a bird; and that the body must have been dragged along the ground like a bat."†

The body was not covered with feathers, but probably with a thick skin, and the "whole osseous system is modified in accordance with the possession of wings;

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* "Oss. Foss.," t. v. p. 358. "Ce n'étoit pas seulement," &c.

† Palæontology, p. 245.

the bones being light, hollow, most of them permeated with air-cells, with their compact outer walls."

The Pterodactyles are distributed into sub-genera, according to well-marked modifications of the jaws and teeth. The teeth of one genus are of two kinds, and it is therefore named by Owen Dimorphodon (teeth of two forms): it is the oldest known species from the Lias.

The *Dimorphodon macronyx* was, when living, about the size of a raven; and the skeleton was discovered by the late Mary Anning in the lower lias of the coast of Dorsetshire, near Lyme Regis. This specimen is now in the British Museum, and was described by Dr. Buckland.* Dr. Bowerbank was the able observer who first recognized the difference, by microscopic investigation, between the form and proportion of the bone-cells in birds and the flying reptiles. He has a fine collection of Pterosaurian fossils; some specimens from the Kentish chalk, indicating a width of wing of from sixteen to eighteen feet. Bones of Pterosaurians are abundant at Sarsden, near Chipping Norton, in Oxfordshire, associated with remains of Megalosaurus and of Oolitic fishes. The beds are the equivalents of the Stonesfield slate, and Professor Huxley has determined that the Pterosaurian relics of the Stonesfield slate belong principally to the genus of flying reptiles denominated Rhamphorbynchus, from the fact of the anterior end of the jaw passing into an edentulous point, to which a horny beak was probably fitted.

Dr. Wright, of Cheltenham, my friend Captain Guise, and the Rev. Mr. Witt, have collected Pterosaurian bones and teeth from the Stonesfield slates of Gloucestershire, all of which belong to the genus Rhamphorhynchus. Professor Huxley informs us that "seven feet may be safely assumed as the minimum distance between the extremities of the two wings" of the largest Rhamphorhynchus,* which he has described from a specimen in the possession of Earl Ducie.

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* Geological Transactions, vol. iii. p. 217.

Order 7.—THECODONTIA.

Socket-toothed saurians.

The remains of the reptilian fossils called Thecodonts, from having their teeth implanted in distinct sockets, as in the crocodile, were first discovered by Dr. Riley and Mr. Stutchbury in the dolomitic conglomerate of Redland, near Bristol, a rock which I believe to be the equivalent of the Haffield conglomerate of the Malvern Hills, and to belong to the age of the upper Permian period.

The Palæosaurus (ancient lizard) has been found at Redland; and a nearly-allied genus, Cladyodon, was founded by Professor Owen on some reptilian relics published by Murchison and Strickland, from the Red sandstones of Warwickshire, now understood to be of Permian age.

The remains of the Telerpeton (a far-off reptile), or *Leptopleuron lacertinum* of Owen, a small lizard-like reptile, were discovered in the Elgin district, in a rock intermediate between the upper Old Red sandstone as the base, and a series of Triassic and Lower Liassic strata above. With the Telerpeton have been found other reptilian remains, showing affinities to lizards and crocodiles, one of which is the Stagonolepis, or pitted scale, and another the Hyperodapedon Gordoni.† All the reptiles, in fact, which have been found in the reptiliferous sandstones of Elgin are considered by Professors Owen and Huxley to have general affinities with the Mesozoic reptiles.

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* Quarterly Journal, Geological Society, Feb. 1860, p. 670.

† Ibid., Aug. 1, 1859, p. 440.

Mr. Moore, of Bath, when visiting the section at Linksfield, near Elgin, in the autumn of 1859, recognized a similarity of appearance between the shales and thin limestone bands at Linksfield and those of the Bone-bed series (at the summit of the Trias), at Pyll Hill, near Bristol; at Aust Passage, at Penarth, on the Severn ; and at the Uphill cutting, on the Great Western railway. Mr. Moore also collected remains of Plesiosaurus, Hybodus, Lepidotus, Acrodus, with Cypris, Estheria* and Mytilus, Modiola, Unio and Cyclas, from the Linksfield beds. Having been informed by Mr. Moore of his belief that the Linksfield beds were Lower Liassic and Triassic, and having seen the fossils he had collected, I visited the Elgin district, in company with Lord Enniskillen, Sir C. Lyell, Sir W. Jardine, and Professor Harkness, for the study of the physical relations of the Elgin rocks.

Without entering into the details necessary to describe the physical geology of this difficult district, I may mention that I entirely agree with Mr. Moore in his correlation of the Linksfield strata, and that they belong to the age of the Upper Trias and Lower Lias.†

Order 8.—DINOSAURIA.

Terrible saurians.

The teeth and bones of a large carnivorous reptile named the Megalosaurus (great lizard) have been found in the Lower Oolite rocks of Gloucestershire, at Selsby Hill and Chipping Norton. They are abundant in the Stonesfield slate, and in the Wealden

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* This is the Keuper Estheria, the *Estheria minuta* of Mr. T. Rupert Jones.

† See Edinburgh New Philosophical Journal, July, 1860.

PLATE 8.

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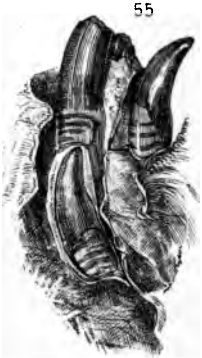
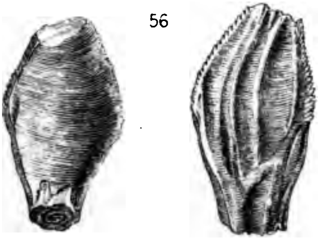


TEETH OF THE MEGALOSAUR.

56



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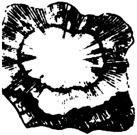
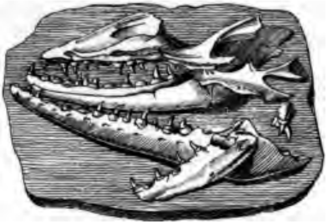


ORN TOOTH OF IGUANODON.

59

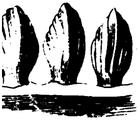


THE MOSASAURUS.

58

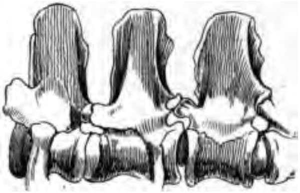
TOOTH OF A YOUNG IGUANODON.

61



ETH OF IGUANA UBERCULATA.

60



CUP & BALL VERTEBRÆ.

61 a

and Purbeck deposits. Specimens of teeth and bones are preserved in the British Museum, and in the Museums at Oxford and Cirencester, also at Bristol. The first scientific determination of the nature and relations of this reptile was by Dr. Buckland in 1824. The character of the teeth leaves no doubt that the Megalosaur was a carnivorous reptile; it appears also to have been terrestrial, and probably preyed on smaller reptiles, and on the young of its contemporaries, the gigantic Iguanodon and Hylæosaur. The structure of the teeth, and their adaptation for destruction, are admirably described by the late Dr. Buckland.*

The Hylæosaurus, or lizard of the forest, was another gigantic terrestrial reptile, first discovered by Dr. Mantell in the Wealden strata. It probably attained a length of twenty-five feet; while the Megalosaur is supposed to have reached thirty feet in length. We are informed by Owen that the teeth indicate "a mixed or vegetable diet, rather than a carnivorous one."

The Iguanodon was an immense herbivorous Dinosaur, the relics of which are found in the Weald of Sussex. It is named, from the resemblance of its teeth to those of the existing Iguana of South America. Dr. Mantell and Baron Cuvier were the first to detect the deviation, in this gigantic reptile, from all the known types of reptilian organization; and their discovery has been followed up by Professor Owen.† "The Iguanodon was distinguished by teeth resembling in shape those of the Iguana, but in structure differing from the teeth of that and every other known reptile, and unequivocally indicating the former existence, in the Dinosaurian order, of a gigantic representative of the small group of living lizards, which subsist on vegetable substances." The Iguanodon must have been a colossal herbivorous reptile, adapted, like the large herbivorous mammalia of our own and former geological periods, to obtain support from vegetable substances. Dr. Mantell thought it probable that the largest Iguanodons may have attained a length "of from sixty to seventy feet." The remains of cycadeous plants are found imbedded with its relics, and may have constituted its food. A good restoration, by Mr. Hawkins, may be seen, with other representations of extinct animals, at Sydenham.

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* Bridgewater Treatise, p. 236.

† Owen's Palæontology, p. 265, &c.

Order 9.—CROCODILIA.

Crocodiles.

Living Crocodiles are divisible into three genera. The true Crocodiles are found in Africa, and may be known by their broad heads. The Gavials inhabit Asia, and have long, pointed heads; and the Alligator frequents tropical America, and is flat-headed. All these genera differ in the arrangement of their teeth.

There are many extinct genera of these reptiles; and Professor Owen has divided the order into three distinct groups, determined by the shape of the vertebræ and the modification of the teeth. He named the genus Cetiosaurus, from a resemblance to the whale and its gigantic proportions; some of the vertebræ of the tail of a Cetiosaurus, from the Portland Oolite, measure seven inches nine lines across, and seven inches in length.

All the existing forms of crocodiles are procœlian, that is to say, the vertebræ have the cup at the forepart, and the ball behind; whereas we learn that the similar but more ancient forms from the Lias and Oolite had the vertebral surfaces hollowed at both ends. The number of teeth is greater in the Gavial of Asia, than in either the Crocodile of Africa or the Alligator of America. The first appearance of Crocodilians with vertebræ, like those of living species, is in the greensand of North America. Forms of these animals, allied both to the gavial and the alligator, were associated with true crocodiles in the tertiary rivers of ancient England.

Order 10.—LACERTILIA.

Lizards, monitors, iguanæ.

Many persons suppose that the common Newt (Triton) is a lizard, and it is generally so called. Nevertheless, the Newt is not a lizard, but belongs to the frog and salamander tribe, the Batrachia or Amphibia.

Specimens of true lizards may be studied in the Gardens of the Zoological Society in the Reptile-house; and among the most remarkable forms, are the Stumped-tailed Lizard (*Trachydosaurus rugosus*), the Great Cyclodus (*Cyclodus gigas*), the Sand Lizard (*Scincus marinus*). The Monitors frequent the haunts of Crocodiles, and are so called from a warning, whistling sound which they are said to give on the approach of those dangerous reptiles. The Iguanæ are common in tropical America, where they live on trees, and subsist on fruit, grain, &c. The female deposits eggs as large as those of a pigeon.

The Cheirotes and Chalcides are forms of Lizards, which appear to constitute a link between lizards and serpents.

The remains of many land lizards have been found in tertiary deposits; others have been discovered in the Purbeck beds, and the remains of an enormous marine lizard, called Mosasaurus, or Lizard of the

Meuse, are preserved in the Jardin des Plantes, in Paris. The *Mosasaurus Hoffmani* was discovered on blasting the rock in one of the caverns of St. Peter's Mountain, near Maestricht; the jaws being attached to the roof of the cavern. So precious was the relic, that when the town was bombarded during the French Revolution, the artillery was not allowed to play on that part of the city in which the fossil was known to be preserved. There is a model of the Paris specimen in the British Museum, which was presented to the eminent geologist and palæontologist, Dr. Mantell, by Baron Cuvier. The head of this animal was five feet in length. Two other species are determined, one from the cretaceous beds of North America, and the other from the chalk of Sussex.*

Order 11.—OPHIDIA.

Slow-worms, snakes, serpents.

The common Slow-worm, or Blind-worm of Great Britain, the Clothonia (*Clothonia Johnii*), and the Glass Snake (*Pseudopus*), appear to be intermediate between the lizards and the snakes. The jaws of these animals are not capable of *distention*, and we learn from Cuvier that they are closely allied to the Scinques and the Seps, lizards remarkable for the shortness of their feet. The connection between the lizards and this first family of Ophidians must be very close. The true lizards have four limbs; but the lizard-serpent, the Cheirote, has two fore feet and no hind ones; and the Bipes possesses two hind feet but no fore ones; while of the Blind-worm and Glass Snake we are informed that they have an imperfect pelvis, a small sternum, scupulars, and also clavicles, ***hidden beneath the skin.*** Specimens of the Glass Snake, Clothonia, and Trogonoph, may be seen in the gardens of the Zoological Society, and are classed by naturalists among the lizards, but having externally the general appearance of snakes.

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* Owen's Palæontology, p. 279.

The serpents may be divided into three groups—the Pythons and Boas, which destroy their prey by compression, and are gifted with wonderful muscular power; the venomous serpents, as the Rattle-snake, Cobra, and the common Viper (*Pelias Beras*); and the Colubrine, or harmless snakes, as the common Ring-necked Snake (*Natrix torquata*) of Great Britain.

The jaws of all the serpents of these different groups are adapted for swallowing animals, and therefore are capable of great distention.

The Reptile-house in the gardens of the Zoological Society contains a fine exhibition of the serpent tribe.

The description of the Boa and his prey is very graphic in the Guide:—

> " When a Boa dashes at his prey, he generally preserves his hold of the tree by a coil or two towards the tail. He seizes with wide-spread jaws, and from that point of attachment throws, with the rapidity of thought, the folds of his vast body round and round his victim. Tightening as they fall, and crushing rib and limb within their embrace, these folds relax not until life is pressed out: and then slowly and carefully withdrawing from the motionless carcase, the Serpent pauses for a few moments, either to recover from the writhings of his struggle, or to assure himself that death is real. Soon, however, he begins to touch the carcase gently with his muzzle, not as popular belief will have it, to lubricate in preparation for the gorge, but to find the head, at which he likes best to begin. This preliminary settled, the jaws again and again dilate until the rami separate, until the skin is strained so wide that every scale is isolated, and grasp following upon grasp, like wave after wave, gradually and irresistibly engulfs the body, which, in its passage through the folds, has been compressed and attenuated into the most convenient possible form for this final operation."

Some of the venomous snakes assimilate very closely in colour with their peculiar haunts, whether those are rocks, sands, or foliage, and the harmless Green-tree Snake is of a grass green.

The Palæophis (ancient serpent) is the earliest known ophidian reptile, and was obtained from the Eocene tertiaries of Sheppy. We also learn from Professor Owen,* that the remains of a "boa-constrictor-like snake," of about twenty feet in length, have been obtained from the Eocene tertiaries of Bracklesham; that a species of true viper has been discovered in the Miocene deposits of France; and three fossil snakes, allied to our common ringed Snake, are known in the Œningen slates (a lacustrine deposit of the upper tertiary age), and have been named *Coluber arenatus*, *Coluber Kargii*, and *Coluber Owenii.*

Order 12.—CHELONIA.

Tortoises and turtles.

The Chelonians exhibit a remarkable modification in the skeleton of vertebrated animals. The bones of the back form a strongly-arched buckler, called the carapace, and the bones of the chest present an extraordinary development named the plastron, which, with the carapace, form a shield composed of a great number of bony plates, into which the animal may withdraw itself.

The edible or Green Turtle attains a length of six or seven feet, and a weight of eight hundred pounds. It feeds upon Algæ in the depths of the sea, and deposits its eggs, which are delicious food, upon the sand of the sea-shore. The Hawk-billed Turtle, which is found in the Mediterranean, feeds on shell-fish, and the flesh is not eatable.

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* Palæontology, p. 280.

Tortoises require very little nourishment, and can pass many months without eating; their jaws are invested with horn like those of birds. The land Tortoise (Testudo) inhabits Greece, Italy, and Sardinia. It is eaten in Greece. Among the foreign species, there are several of large size. The Emydes, or Freshwater Tortoises, live on insects and small fish. The soft Turtles (Trionyx), of the Nile, and the American rivers of Carolina, Georgia, and Florida, devour the young crocodiles and alligators as soon as they are hatched.

Turtles were inhabitants of this planet long before the days of aldermen and soup. Fossil footprints of Chelonian animals are described by Sir Wm. Jardine from the Permian sandstones of Dumfriesshire; * and footprints similar to these have been discovered by Mr. Binney, and Dr. Marshall of Cheltenham, in the Carboniferous sandstones.

Professor Owen has described a fossil Turtle (*Chelone planiceps*) from the Portland stone (Upper Oolite); and marine Turtles have been found in the Chalk, Eocene, and Miocene deposits. The estuarine, crocodile-devouring genus, Trionyx, "is represented by many beautiful species in the Upper Eocene at Hordwell." "Remains of land tortoises (Testudo), indicate several extinct species in the Miocene and Pliocene formations of continental Europe,"† and Dr. Falconer, the eminent palæontologist, discovered in India a carapace of a tortoise twenty feet in length.

* Sir W. Jardine's "Ichnology of Annandale."

† Owen's Palæontology, p. 283.

Order 13.—BATRACHIA.

Toads, frogs, newts.

The Batrachia, Frogs, Toads, Salamanders, &c., were long classed with the Reptilia, but Professor Owen has determined that they approximate to the fishes. The comparative anatomy of these animals is an intricate and elaborate problem, and far beyond our province to explain. It must suffice to say that the Batrachia belong to Fish rather than to reptiles in their development, whilst in the egg; in their fish organization, as tadpoles, at their birth; and in their circulatory apparatus after their metamorphosis. When tadpoles, they live in the water and possess gills (branchiæ), projecting externally, which disappear in most of the Batrachians after they have undergone their metamorphosis. Those Batrachia which lose their external gills when adult, acquire very feeble lungs, and thus appear to be linked with the reptiles; but there are adult Batrachians which never lose their gills, as the Proteus and Siren; and the swimming-bladder of fishes is a rudimentary lung. The circulatory apparatus also undergoes great change, after metamorphosis; but, as I understand, it is of fish rather than of reptilian development.

When the tadpole of the Frog is metamorphosed into a Frog, the hind feet appear first, and at some length of time before the fore feet. In the tadpoles of the Salamander, the fore feet appear first, and the hind feet last; while the tail continues to grow instead of dropping off, as in the frog tadpole. The Salamander is generally spoken of and considered as a lizard, for it possesses four limbs and a long tail; nevertheless, from other parts of its organization this animal is ranked with the Urodeles or tailed Batrachians.

The Axoloth, a Mexican batrachian, is one of those extraordinary animals which puzzle comparative anatomists. It resembles most nearly the tadpole of a salamander,—a salamander stopped short, as it were, in its development. It is, however, a fully-developed animal, and not a tadpole.

The Siren has tufted gills, with the shape of an eel, and no hind feet; while the Proteus is a blind batrachian, that lives in eternal darkness in the subterranean caves of Carniola, and possesses four legs almost as useless as are its rudimentary eyes.

The Lepidosiren, which may be seen at the Crystal Palace at Sydenham, possesses an organization which may be termed intermediate between the batrachians and fishes. It has rounded fins instead of feet, and the internal organization of a fish, but with external gills (branchiæ), and lungs like the siren. It is a fresh-water animal.

The Batrachians are divided into two groups—the Anures, without tails, and Urodeles, with tails. The frog is an example of the first, and the common water-newt of the latter.

The Zoological Society of London possesses a specimen of the largest *existing* Amphibian, the gigantic Salamander (*Sieboldia maxima*). It is a native of the Japanese island Niphon, inhabiting the lakes and streams of the volcanic range of mountains of the interior. The society also exhibits specimens of the Spotted Salamander (*S. maculosa*), the Black Salamander (*S. nigra*), the British Newts or Tritons (*T. cristatus* and *T. punctatus*), and the Amphiuma (*Amphiuma tridactylum*). These specimens are in the Python-house.

The largest known species of tail-less Batrachian is the Surinam toad. The male of this species places the eggs of the female upon her back, the skin of which swells so as to form a number of cells, which inclose the eggs. The tadpoles pass their first state in these cells, until they have developed their limbs and parted with their tails. Two species of toads are found in Great Britain. The "Natterjack" is common in the neighbourhood of the Reeks, near Killarney, in Ireland. It has a yellow stripe, and has been found in Worcestershire and other parts of Great Britain. Specimens of the beautiful Tree Frog (*Hyla viridis*), the Green Toad (*Bufo viridis*), the North American Croaker, the Bull Frog (*Rana mugiens*), may be seen in the Python-house of the Zoological Society.

The celebrated fossil man, which was supposed to be a proof of the universality of the Noachian deluge, and the skeleton of which was discovered in the tertiary beds of Œningen, A.D. 1726, turned out to be a water salamander, and is allied to the gigantic water salamander of Japan, already alluded to.

Toads of extinct species have been discovered in the same beds as the Œningen salamander; and frogs in the Miocene and Pliocene deposits of France and Germany; even tadpoles have been found fossil near Bonn.

For a retrospect of the palæontology of the great class of Reptiles we must refer our readers to the able *résumé* of Professor Owen.* The Professor informs us that this ancient class of animals, ancient as, at least, the far-off Carboniferous epoch, is, "unlike that of fishes, now on the wane;" and that the period when Reptilia flourished under the greatest diversity of forms, with the highest grade of structure, and of the most colossal size, is the Mesozoic; that long epoch, during which the middle-life forms, the myriads of animals of the Triassic, Liassic, Oolitic, and Cretaceous systems, were created, lived their appointed span, and died out.

"Reptiles have been superseded by air-breathers of higher types, which cannot be directly derived from the class of fishes."

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* Palæontology, p. 289.

The oldest known reptiles, which almost appear as if they were developed from the Ganoid fishes, the Ganocephalous reptiles, began and ended in the Carboniferous period. The Labyrinthodonts of the Trias disappeared at the base of the Oolitic system. The Dinosaurs, Cetiosaurs, Protosaurs, and Ichthyosaurs passed away before the commencement of the Tertiary Epochs. The Chelonia are on the wane, as are the crocodiles; while the true Batrachia began to decline after the Upper Tertiary period.

CHAPTER IV.

CLASS IV.—**PISCES.***

Fishes.

FISHES are separated into two great divisions, viz. *Osseous* fishes, or such as possess a hard bony skeleton, and *Cartilaginous* fishes, or those whose skeletons are composed of soft, elastic animal matter, termed cartilage.

In Osseous fishes the structure of the head is very complex, being composed of a great number of distinct bones; the skull of the cartilaginous fish, on the contrary, consists of a single piece, without any joints.

M. Agassiz arranges fishes into four orders, according to the structure of their scales. These are again divided into sub-orders, &c., by Professor Owen and others.

Order 1. PLACOIDS (broad plated scales)—sharks and rays.

„ 2. CHIMÆROID FISHES—king of the herrings.

„ 3. GANOIDS (shining scales)—sturgeon, lepidosteus, and a great number of fossil fish; as the cephalaspis, osteolepis, &c.

„ 4. CTENOIDS (comb-shaped scales)—perch, basse, serranus, &c.

„ 5. CYCLOIDS (simple marginated scales)—salmon, whiting, cod, herring, &c.

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* See Palæontology (Professor Owen's) and "Poissons Fossiles" (M. Agassiz).

The Ctenoids and Cycloids constitute the orders comprehending the ordinary fishes with bony skeletons. The Cartilaginous fishes seem to be an approach toward the batrachian; and, on the other hand, there is an animal admitted by naturalists into the class of fishes, but placed at the bottom of the scale, which has neither vertebræ, red blood, heart, nor distinct brain. This is the Amphioxus, a rare fish, which Pallas believed to be a molluscous animal, but which is now ranked as a fish of the lowest grade; and appears to be a link between the vertebrate and invertebrate animals. The Amphioxus is a British fish, and an inhabitant of the sea.*

Fishes are distinguished from other vertebrated animals by their mode of respiration, being furnished with gills instead of lungs. They have to respire water, in which the oxygen is dissolved, instead of air, and their gills are beautifully adapted for this purpose.

No animals exhibit such extraordinary aberration of form, or assume such peculiar shapes. Nor is this aberration peculiar to recent fishes. The Semiophorus of the tertiary deposits of Monte Bolca was as strange in contour as the Hippocampus, or the File-fish. The adaptations of fish are also astonishing. There are flying fish; walking and climbing fish; electrical fish; fish with an apparatus for adhesion, as the Remora; fish adapted to hot waters, and others to dark caves; musical fish; and fish which can live for months baked into the earth.†

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* Yarrell's "British Fishes."

† Tennent's "Ceylon."

Order 1.—PLACOIDS.

Fish with plated scales.

Sub-order. Plagiostomi.

Fish with mouths opening under the head, or oblique-mouthed.
Sharks, rays, cestracionts.

This order is divided into sub-orders, the Plagiostomi, of which several families of the Sharks and Rays are living in the present seas; and the Cestracionts, of which most of the genera are extinct.

Fish have two forms of tails, which furnish a marked distinction. The shark and the sturgeon have their tails unequally lobed, or heterocercal (*heteros*, different; and *cercos*, a tail), and the backbone is prolonged into the upper lobe. It is remarkable that in all fish found in rocks older than the Lias, their tails are unequally lobed. In the Lias, and rocks above the Lias, fish begin to show the homocercal form of tail; that is, their tails are equally lobed (*homos*, alike), while in the Tertiary deposits, and at the present time, the majority of fish have homocercal tails.

The shark, dog-fish, and sturgeon affect the old type, and are examples of living fish with heterocercal tails.

The Shark possesses an oblong body, lessening towards the tail; the back is broad, and supports a lofty fin; the tail is a rudder of great strength; and the pectoral fins form a pair of powerful oars. Underneath the upper part of the head are the gulf-like jaws, full of serrated, sharp teeth.

Sharks are said to hunt in company, like wolves; but no wolf equals some of these sea monsters in voracity and audacity. Gilius and Rondeletius record that a man in armour was found in the interior of a shark taken near Nice; and that another shark, when placed upon a car, was almost too heavy for a pair

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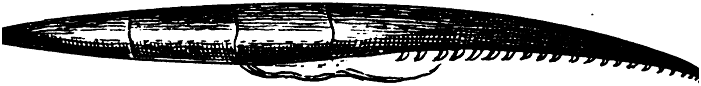
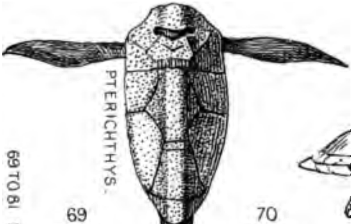


A FISH SPEAR.

63



PTERICHTHYS.

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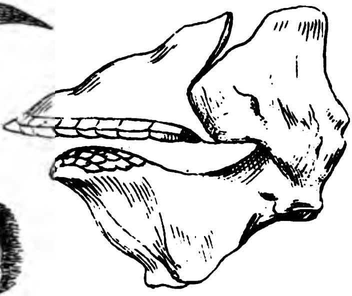

FISH JAW WITH CRUSHING TEETH.

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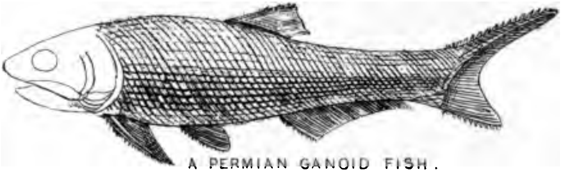
69 TO 81 FISH SCALES & TEETH.



A PERMIAN GANOID FISH.

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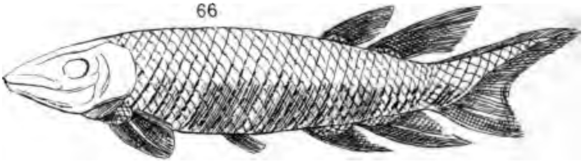
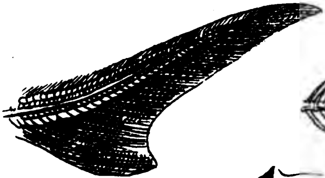


A GANOID FISH OF THE OLD RED.



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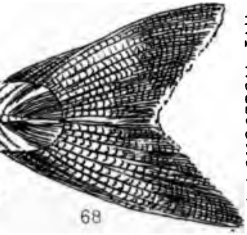
A HETEROCERCAL TAIL.



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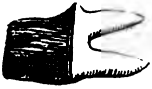
A HOMOCERCAL TAIL.



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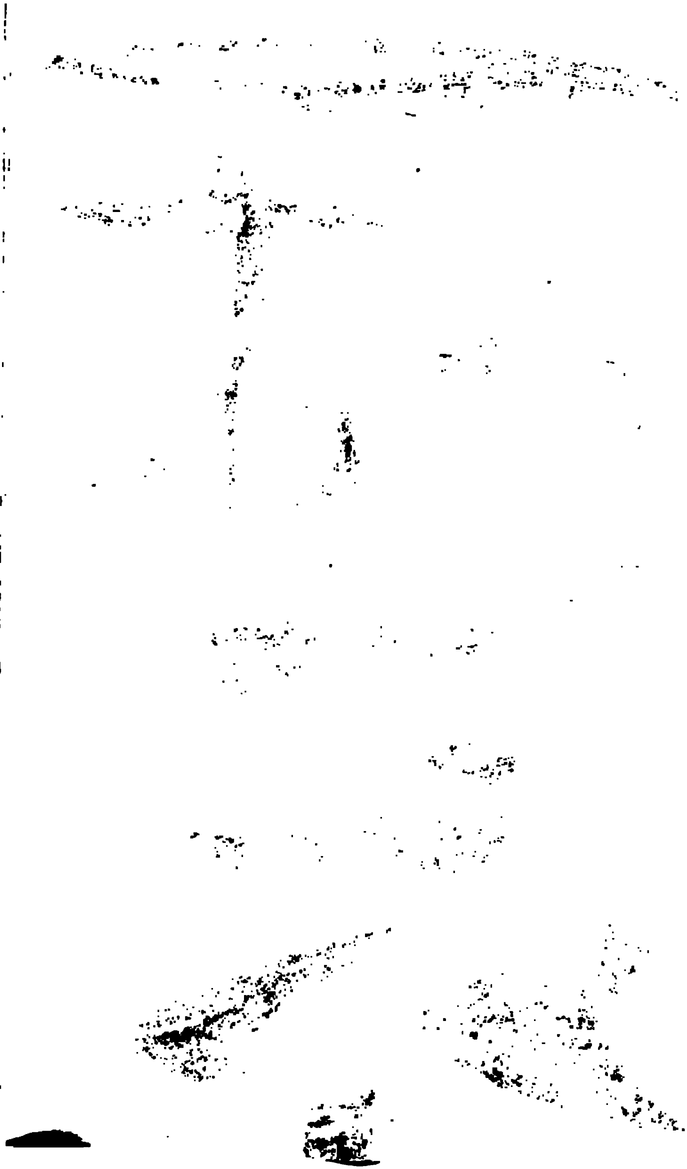

of horses to drag along. Sharks appear to be endowed with some of the emotions of higher animals; for Admiral Smyth mentions that he saw a large female hooked in Mahé Bay, while she was cruising around the Cornwallis, and that while she was being drawn alongside, they saw a number of young sharks rush for safety into their mother's mouth. When the belly of the shark was opened, no fewer than thirty-eight young sharks tumbled out alive: they were nearly two feet in length, and the mouths admitted a man's hand.*

The Dog-fishes—a genus of shark-like fishes—of the British coast are known to the frequenters of the seaside; and the geologist learns from the Ichthyologist and comparative anatomist, that the small spines from the upper Ludlow bone-beds belonged to a fish which was allied to the Dog-fish (Acanthias). The shagreen, or skin, of other small prototypes of the great shark order of fishes, has also been detected and referred to a genus named Sphagodus. These fish, although they may be ranked with the highly-developed sharks and dog-fishes, were nevertheless very small. We must not forget, also, that Professor Owen says that the defensive spine of the Onchus "indicates its danger;" and that fishes of larger size, and of carnivorous habits, frequented the seas of the upper Silurian epoch. Many fossil spines of shark-like fish have been discovered in strata of the age of the Old Red sandstone; and many species of ancient fishes have been erected on the relative shapes and sizes, &c., of these spines. Onchus is represented in the Old Red sandstone; and I have seen some good-sized defences, belonging to fish of this genus, from the Lower Old Red of Ledbury, Herefordshire. Other fin-spines have been termed Ctenacanthus, Ptycacanthus, Pleuracanthus, &c. This latter ichthyodorolite (spear of a fish in stone) is believed by M. Agassiz to be the spear of a fish allied to the Sting Ray (Trygon), which has on the tail a strong spine notched on both sides. The spines of the genera of fishes above named are common to the Old Red, and the succeeding Carboniferous epoch; and numerous other genera have been erected upon fossil spines found in the coal formations. The superimposed formations, the Permian, Trias, Lias, Oolitic, and Chalk formations, all furnish their fish spears, testifying the existence of shark-like owners in the seas of the different epochs.

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* See *Fraser's Magazine*, March, 1859.

Several species of Rays (Raia) or Skates are found in the seas of Great Britain. These fish usually lie in wait for their prey at the bottom of the sea, and their eyes are fixed on the same plane on the upper side of the head. The Torpedo (*R. Torpedo*) is a Ray that possesses the power of giving an electric shock so powerful, that, when Reaumer put a torpedo and a duck into a vessel filled with sea-water, the duck was killed in less than three hours. The common torpedo is occasionally taken on the Channel coast of England.

The teeth of sharks and rays have been found in abundance in Tertiary deposits. Fossil teeth of an enormous Shark (Carcharodon) have been found in the red crag of Suffolk, and indicate a fish sixty feet in length; for some of the teeth measure six inches in height. Fossil teeth of the ray family, with their pavement-like jaws, are found in secondary and tertiary formations. In short, we know that fishes of the shark and ray order lived from upper Silurian days until now.

The Cestracion, or "Port Jackson Shark," is one of those remarkable forms, still living, which connect the present world of living beings with forms and shapes that have long since passed away. The Cestracionts, now restricted to the seas of China and Australia, have left their remains in thousands, in rocks of the Secondary epoch in Great Britain and Europe. The Port Jackson shark, and one or two other species, are the representatives of a vast number of forms that have become extinct. The teeth of these fishes are adapted for crushing shell-fish and crustaceans, and they are provided with spines on the back for their protection. The crushing teeth, which were set as in a pavement, and dorsal spines, are full of interest to the geologist.

The Orodus of the Carboniferous rocks is the tooth of a fish, allied to the Port Jackson shark, which lived in the days of the Mountain limestone. Hybodus, a form of tooth which occurs in the Keuper sandstone of Worcestershire, and Lophodus,* which is still more abundant in the same rocks, were both the crushing teeth of Triassic Cestracionts. The "Fossil Leech" (Acrodus) of the Lias and the Ptychodus, of the chalk, are teeth that belonged to fishes allied to the Australian Cestracion. Mr. Moore, of Bath, extracted 45,000 teeth of Lophodus from three cubic yards of Triassic earth.

Order 2.—HOLOCEPHALI.

Chimæroid fishes.

There is a fish known as the Cat of the Mediterranean, and the "King of the Herrings" of the northern seas, and which closely resembles the shark in form. It is about three feet long. This is the *Chimæra monstrosa* of naturalists. There is another genus or sub-genus represented by two species from the Australian and Chinese seas,† and which have the snout ending in a fleshy appendage. These are all that are now known to be living of an order of cartilaginous fishes which, like the Cestracionts, says Professor Owen, seem "to be verging towards extinction." The genera Ischiodus, Ganodus, Edaphodus, and Elasmodus, of Egerton, were all allies, in former geological epochs, of the "King of the Herrings," and have been determined by their fossil jaws and spines. Ischiodus is found in the Lias. Chimæroid fishes are thus known to have ranged from the Liassic epoch to the present time.

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* The Lophodus teeth are generally known as the Acrodus of the Trias. Sir P. Egerton and M. Agassiz consider that these teeth differ from Acrodus. They are associated with the *Estheria minuta* of Mr. T. Rupert Jones.

† Owen's Palæontology, p. 116.

Order 3.—GANOIDS.

Fish with shining scales.

Sub-order. **Placoganoids.**

Ganoids protected with plates of enamel.

In America there is a fish known as the Bony Pike, of which there are three or four species. This is the Lepidosteus of naturalists, the name referring to the hard, bony scales with which they are covered.

The Polypterus, also, of the African rivers, has the head covered with bony plates, and the body with strong scales. These are representatives—and there are few living representatives—of the great order of fishes, now nearly extinct, known to geologists as the Ganoidal fishes of the palæozoic and secondary rocks.

There are rare living forms of fish, besides the Lepidosteus and Polypterus, which may give the naturalist an idea of the form and structure of the strange fishes of the Old Red epoch. Sir William Jardine possesses specimens of fish, natives, I believe, of the Brazils, which are defended by a cuirass that might have served an Old Red Ganoid. I suppose these specimens of Sir William's to belong to the Ostracions (Trunk fishes), alluded to by Professor

Owen. They are not, I imagine, true ganoids. Loricaria, one of the Siluridæ, or Sheat fishes, is a living fish, of which students should see a prepared specimen, if possible; and also the Sturgeon (*Acipenser*) which is a ganoid with plates. The sturgeon is a fish known even to country people that rarely visit the seaside. It is occasionally taken in our rivers, and exhibited in most country towns. The general form is that of a shark, but the body is covered with plates in rows. The great sturgeon of the Don and the Volga grows to the length of from twenty-five to thirty feet. The common sturgeon is about six feet long. Caviar is the roe of the sturgeon, and isinglass is made from its swimming-bladder. There is a transitional form of sturgeon, between the true ganoids and sturgeons, found in the Lias.*

At present the *Pteraspis Ludensis*, a plate-covered ganoid fish, is the earliest known indication of a vertebrate animal.

The remains of several other ganoid fishes have been lately discovered in the rocks which lie as passage-beds between the Silurians and the Old Red Sandstone.

We imagine that Professor Owen was ignorant of the discovery of a fish in Silurian deposits, vastly older than the beds in which *Pteraspis truncatus* was discovered near Ludlow, or he would have mentioned that discovery. The writer of these notes brought before the notice of the Malvern and Cotteswold Field Clubs (May, 1859), and again before the British Association at Aberdeen, a letter from Mr. Lightbody, of Ludlow, announcing the discovery of a fossil fish by Mr. Lee (*Pteraspis Ludensis*, Salter) in the Lower Ludlow rock of Leintwardine, Herefordshire. There cannot be a shadow of a doubt that the rock is the Lower Ludlow deposit of Murchison, and no one save the geologist, who knows the thickness of the Upper Ludlow shales and the Aymestry limestone, which intervenes between the site of the deposition of the *Pteraspis truncatus* and that of the *Pteraspis Ludensis*, can adequately comprehend how much the discovery of this little fish antedates the period during which fish have been now proved to have existed on this planet.

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* **Palæontology, p. 145.**

After those oldest known forms of fish (the Pteraspides of the Lower and Upper Ludlow deposits), we find the small defences of Onchus, &c., in the beds immediately superimposed; and we have, at Ledbury and Ludlow, remains of the Cephalaspis (shield on the head), associated with Auchenaspis (shield on the neck), and remains of Crustaceans, Pterygotus, &c. These are, without doubt, the lowest beds of the Old Red sandstone, and contain most of the earliest known forms of fish. The forms of Pteraspis and Auchenaspis are little known, and we await the researches of Professor Huxley, who is engaged in the examination of those antique fishes. They belong to the family of the Cephalaspides. Of the Cephalaspis and Coccosteus, enough is known to enable the student to obtain a good idea of the shape. The bones of the head constituted a shield-like cuirass, terminating behind with three spines. The body seems also to have been protected by enamelled bands. As nothing is known of Pteraspis and Auchenaspis but the plates of the head and back, it is probable that only a portion of these fishes was cased in armour.

The Pimelodi of the Ganges have a helmeted head, and a distinct dorsal plate of bone between the helmet and the dorsal spine. The late distinguished geologist Hugh Miller instances the *Pimelodus gulio*, specimens of which are in the Elgin Museum, as probably illustrative of some of the ancient Ganoids. This Pimelodus is "a little strongly-helmed fish, with a naked body; and I was informed by Mr. Duff, on the authority of the gentleman who had presented the specimens to the Museum, that it burrowed in the holes of muddy banks, from which it shot out its armed head, and arrested, as they passed, the minute animals on which it preyed."* The Cephalaspides belong to the Lower Old Red, with the exception of Coccosteus (berry on bone), which is a Cephalaspidean fish, of the Middle Old Red of Scotland and Russia. The Pterichthys, or winged fish, is a singular form among the Old Red ganoids.

"Of all the organisms of the system," wrote Hugh Miller, "one of the most extraordinary, and the one in which Lamarck would have most delighted, is the Pterichthys, or winged fish." "Had Lamarck been the discoverer, he would unquestionably have held that he had caught a fish almost in the act of wishing itself into a bird." "I fain wish I could communicate to the reader the feeling with which I contemplated my first found specimen. It opened with a single blow of the hammer; and there, on a ground of light-coloured limestone, lay the effigy of a creature fashioned apparently out of jet, with a body covered with plates, two powerful-looking arms articulated at the shoulders, a head as entirely lost in the trunk as that of the ray or the sun-fish, and a long angular tail."†

We would also refer our readers to Professor Owen's account,‡ from which we learn that the Pterichthys possessed a small dorsal fin and a pair of ventrals, first observed by Sir P. Egerton, in addition to the pectoral flaps, which "indicate a certain power of swimming, though not with any great rapidity."

I am not aware that a single species of Pterichthys has been found in the Lower Old Red Sandstone; but several species are known from the middle rocks of this formation, and two from the upper beds. The Upper Old Red, of Farlow, Herefordshire, near the

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* "Rambles of a Geologist," p. 288.

† "Old Red Sandstone," p. 72.

‡ Palæontology, p. 120.

Clee Hills, has furnished a Pterichthys, which Sir P. Egerton considers to resemble most nearly the P. hydrophilus of Dura Den. This specimen was found by Mr. Baxter, of Worcester, associated with the scales of Holoptychius, and was presented by him to Sir P. Egerton.

The Farlow sandstones belong to the yellow group of deposits, which in many parts of Great Britain and Ireland underlie the lowest carboniferous beds; and I have no doubt that they are the equivalents of the celebrated Dura Den rocks of Scotland, the Upper Old Red Sandstone.

Sub-order. **Lepidoganoids.**

Ganoids with scales of enamel.

Family. *Dipteridæ.*

Double-winged or finned fish.

If the reader should ever visit the neighbourhood of Cromarty, in search of fossil fish, and wander along the sea-shore towards the entrance to the bay, the "auld wives" will ask him, as he passes, if he is in search of "Miller's stone," of which that lamented geologist wrote as follows:—

> "There rests in the neighbourhood of Cromarty, on the upper stratum of one of the richest ichthyolite beds I have yet seen, a huge water-rolled boulder of granitic gneiss, which must have been a traveller, in some of the later periods of geological change, from a mountain-range in the interior highlands of Ross-shire, more than sixty miles away. It is an uncouth-looking mass, several tons in weight, with a flat upper surface, like that of a table; and as a table, when engaged in collecting my specimens, I have often found occasion to employ it. I have covered it over, times without number, with fragments of fossil fishes, with plates, and scales, and jaws, and fins, and when the search proved successful with entire ichthyolites."*

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* "Old Red Sandstone," p. 105.

I visited "Miller's stone" last summer, in company with one of his old friends, who loves the lore of the hammer and the "griesly fisch" of the "laithlie flood." The nodules containing the fish seem to be nearly exhausted; and although we obtained remnants of Osteolepis and Dipterus, we did not find the specimens by any means so abundant as when the bed was first discovered by the author of the "Old Red Sandstone."

The Dipterians* are so called from the position and number of their fins. This family, which includes Osteolepis and Diplopterus, has a double anal as well as dorsal fin.

In their more striking characteristics, writes Hugh Miller,† the three genera seem to have nearly agreed. "In all alike scales of bones glisten with enamel; their jaws, enamel without and bone within, bristle thick with pointed teeth; closely-jointed plates, burnished like ancient helmets, covered their heads; their tails were formed chiefly on the lower side of their bodies; and the rays of their fins, enamelled like their plates and scales, stand up over the connecting membrane, like the steel or brass in that peculiar armour of the middle ages, whose multitudinous pieces of metal were fastened together on a groundwork of cloth."

Perhaps the most extraordinary haul, at one time, of the fishes of the Middle Old Red, was when, after the meeting of the British Association at Aberdeen, his Grace the late Duke of Richmond set on a number of workmen to quarry the nodules at Tynet Burn, near Fochabers, and afterwards to break them up. Hundreds of fossil fish were laid open to the light of day. I afterwards saw several of the specimens in the remarkable museum of fossil fish collected by Sir P. Egerton, at Oulton Park.

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* The Dipterus has generally been considered a marked genus of the Middle Old Red. My friend Mrs. Hugh Miller informs me that it has lately been found associated with *Cephalaspis Lyellii*, in the Lower Old Red, by the Rev. Mr. Mitchell.

† "Old Red Sandstone," p. 100.

Family. *Acanthodii.*

Spinous fish.

The Cheirolepis, or scaly pectoral; the Cheiracanthus, or thorny hand; and the Diplacanthus double spine, belong to this family. The scales are very small, and they have strong spines in the front of each fin. Hugh Miller's description of these fish is familiar to every geologist. Professor Owen gives a brief description, which will enable the geologist to distinguish the genera. Cheiracanthus has a single dorsal fin, situated in front of the anal. Acanthodes has the second dorsal fin situated behind the anal; Diplacanthus has two dorsals; while Cheirolepis has no spine in any fin, but possesses the minute scales of the family.

Family. *Cœlacanthi.*

Hollow-spined fish.

The Glyptolepis, or sculptured scale, and the Phyllolepis, leaf-scaled, with the Glyptopomus, belong to the Cœlacanths; so called from the hollowness of their rays or spines. The Glyptolepis is found in the Middle Old Red of Scotland, and the Asterolepis in the Middle Old Red of Russia and Scotland.* The other fish have been found in the Upper Old Red beds in Scotland only.

* Professor Huxley doubts the propriety of grouping the Asterolepis as a Cœlacanth.

The Asterolepis, star-scaled, is found in that wonderful mausoleum of fish that lived and died during the epoch of the Middle Old Red sandstone, and left their skeletons in the bituminous schists of Caithness, and the fish-filled rocks of Cromarty, Tynet, and Lethenbar. Myriads of fish, "of forms the most ancient and obsolete," have left their relics in a former sea-bottom, rendering the beds bituminous, owing to the quantity of animal matter which they contain. Sir Roderick Murchison recommended these flags to be distilled for "stone oil,"* that the people might trim their lamps with the animal matter of fish that lived myriads of ages ago.

The Asterolepis of Miller (Homosteus of Asmus) must have been a large ganoid. "The head of the largest crocodile of the existing period is defended by an armature greatly less strong than that worn by the Asterolepis," and we learn that the structure of the fish was that peculiar half-armed, half-exposed structure to which we have already alluded. "It was a strongly-helmed warrior in slight scale armour; for the disproportion between the strength of the plated head-piece and that of the scaly coat was still greater than in that of Pterichthys."

Few geologists felt more than Hugh Miller the necessity of cautious induction on the value of negative evidence in geological research. It was generally believed and taught that the Old Red sandstone fishes all possessed an interior skeleton of cartilage with an external covering of bone and enamel, and that fish with osseous vertebræ were not created in the days of the Old Red sandstone.

At the British Association at Oxford (1860), Sir Philip Egerton produced a fossil fish discovered by Mr. Peach, which, he informs me, is allied to the Cœlacanths. This fish possesses osseous vertebræ, and is another example of the necessity of caution respecting negative evidence. Sir Philip Egerton has named the fossil *Tristychopterus alatus.*

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* "Siluria," 3rd edit. p. 203.

Family. *Holoptychidæ.*

Wrinkled fish.

Sir Roderick Murchison ranks this family with the hollow-spined fishes the Cœlacanths. Professor Owen says "they are nearly allied to the Cœlacanthians, having, like them, but partially ossified bones and spines, the interior of which retained their primitive gristly state, and appear hollow in the fossils."* There are splendid specimens of this bulky fish of the Old Red epoch in the museums of the Earl of Enniskillen and Sir Philip Egerton. The remains of the Holoptychius have been found in Germany, in Russia, in Scotland, in Herefordshire (at Farlow, associated with Pterichthys), and in Monmouthshire, near Crickhowel, by Sir R. Murchison and the late Rev. T. T. Lewis, in the Upper Old Red deposits.

Besides the wide range of this fish, it is worthy of remark that the Holoptychius nobilissimus of Scotland is found in Russia with marine shells, such as Productus, Terebratula, and Spirifer, and with Corals and Encrinites. So also is Coccosteus found in Germany, associated with marine fossils.† We thus learn that the Ganoids of the Old Red of Scotland were marine, while it seems probable that the fresh-water fishes of that epoch and the succeeding Carboniferous period were also ganoids.

The remarkable fishes of Dura Den have been described by Dr. Anderson, of Newburgh,‡ who has discovered two or three new genera for the ichthyology of Scotland.

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* Palæontology, p. 132.

† "Siluria," 3rd edit. p. 383, &c.

‡ "Fishes of Dura Den."

Professor Owen associates the Dendrodus, known by its large fossil teeth, with the Holoptychian family. The teeth of this large and predatory fish are found in a breccia at Scat Crag, near Elgin. They must have been washed out of some older deposit of the Old Red, as the remains of Permian reptiles have been washed into Triassic breccias. The Holoptychidæ pass into the lower carboniferous deposits, and I am not aware that any of the family have been found higher in the series of rocks.

Family. *Palæoniscidæ.*

The Ganoid fishes covered with enamelled plates (Placo-ganoids), that appear in the Lower Ludlow deposits in the shape of Pteraspis, die out during the long Carboniferous period that succeeded the epoch of the Old Red Sandstone.

The Ganoid fishes covered with enamelled scales (Lepido-ganoids), range from the Old Red period to the Tertiary deposits; yet even in the Early Dawn epoch of present life, the Ganoids were reduced to a "lingering few." The *Dipteronotus cyphus,** from the Trias of Bromsgrove, Worcestershire, is apparently a Ganoid fish, with an intermediate form of tail.

Palæoniscus is a well-known genus of ganoid fishes. Palæonisci are found in the coal formations of Scotland. The Earl of Enniskillen and Sir P. Egerton possess specimens of a beautiful little Palæoniscus (*P. catopterus*) from the Permians of Roan Hill, Tyrone; and the last known of the class was discovered by my friend the Rev. P. B. Brodie, in the Upper Keuper sandstone of Warwickshire. This is described by Sir P. Egerton, under the name of

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* See Quarterly Journal, Geological Society, 1854.

P. superstes.[*] I have seen what I believe to be scales of this fish in the Keuper sandstone of Pendock and Eldersfield, Worcestershire.

Family. *Saurichthyidæ.*

Sauroid or reptile-like fishes.

Among the most striking objects in a collection of fossil fishes, are the jaws and teeth of a large sauroid fish of the Carboniferous period, termed the Megalichthys by M. Agassiz. It must have been, verily, "a great fish;" and it was truly excusable if, in the early days of ichthyological science, the teeth were mistaken for those of crocodiles. Professor Owen gives a long list of the fishes of this family, which appear to have been created during the Carboniferous epoch, and to have reached their zenith in the Triassic period.[†]

Family. *Caturidæ.*

The fishes with the equally-lobed or homocercal tail do not make their appearance until after the Palæozoic periods; and no fish with the homocercal tail has been found below the Lias.

In the rocks of Oolitic epoch, the fish are Ganoids, but Ganoids principally with homocercal, instead of, as in the Palæozoic periods, with heterocercal, or unequally-lobed tails.

Of thirty-three genera of fishes in the Lias, says Professor Owen, four only were represented in older strata, while the rest extend into the Upper Oolitic beds.

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[*] Proceedings of the Geological Society, May, 1858, p. 165.

[†] Owen's Palæontology, p. 139.

There is a bed of the Upper Lias known as the fish-bed. It contains many remains of Ganoid fishes, and also of insects and crustaceans. Those geologists who attended the meeting of the British Association at Cheltenham will remember a remarkably fine fish from the Marlstone and Upper Lias quarries at Stanley Hill, near Cheltenham; also the cracking of a nodule, containing a nearly perfect fish, in section C, by Mr. Moore, the well-known geologist. These fish were Caturidæ, of the genus Pachycormus, thick body, of Agassiz. Fish of this family range from the Lias to the Chalk inclusive.

Family. *Pycnodontes.*

Thick-toothed fish.

These are an extensive family of Ganoid fishes, so called from their thick teeth, which are also round and flat, and adapted to the crushing of testaceous animals on which they fed. They are very like the Dapedius of the Lias, which is so named from the pavement-like arrangement of its rhomboidal scales; but Sir P. Egerton has satisfactorily determined that the difference of the dentition constitutes a different family. The Pycnodonts, in addition to other characteristics given by Sir P. Egerton,* have the small front teeth conical and single-pointed; in the Dapedidæ the front teeth are notched. The Platysomus of the carboniferous deposits is the first known Pycnodont, and the last is one that lived in the epoch of Miocine tertiaries—Dapedidæ † (scales resembling a pavement).

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* Proceedings of the Geological Society, May, 1853, p. 276.

† Owen's Palæontology, p. 143.

The Lias of Barrow-on-Soar is famous for the well-known Dapedius. I possessed a fine specimen from Sarnhill, near Tewkesbury, which I presented to the Earl of Enniskillen. It was found associated with the *Pholidophorus Stricklandi*, one of the Dapedian family, in the insect limestone of Brodie, a rock nearly at the base of the Liassic series of deposits. The Lias is the deposit in which most of this family are found. One genus (Semionotus) ranges to the chalk formation.

Family. *Lepidotidæ.*

Rhomboidal scaled fish.

These fish are Ganoids, covered with imbricated rhomboid scales, from whence the family has received the name. They are found in the Lias; and "one species (*Lepidotus Maximiliani*) lingers, after the commencement of the Tertiary period, in the 'calcaire grossier' of Paris," which belongs to the strata of the Dawn or Eocene period.

Family. *Leptolepidæ.*

Slender-scaled fish.

These little Ganoids take their name from their slender scales. They are common in the Lias and succeeding group of Oolitic rocks. It is hardly possible to crack open a portion of the yellow fish-bed of Dumbleton, Stanley Hill, and Churchdown, near Gloucester, without finding portions of one of the fishes of this family. Miss Holland, of Dumbleton, the Rev. P. B. Brodie, and other geologists, have obtained many perfect specimens from these upper Lias deposits. Many years ago, on the first geological ramble I ever took, I knocked out one of these fish, nearly perfect, on the side of Dumbleton Hill. This settled my fate as a geologist!

The heterocercal Ganoids of the Palæozoic period were succeeded for the most part by homocercal Ganoids of the secondary periods. Again, in the Tertiary periods, this once nearly-predominant order of fishes gives place to the Teleostean (well-ossified) or bony fishes. In the Chalk epoch, fishes with bony internal skeletons become numerous; in the succeeding Tertiary epochs the ganoids are scarce, and the osseous fishes take their place.

When we reflect on the immense number of fishes of this once nearly preponderant order that have died out,—of the very few that are left, we cannot but acknowledge the probable truth of much that Mr. Darwin advances in favour of the preservation of certain relics of ancient forms by the force of favourable circumstances. On an island, for instance, distant from a continent, the race of life will have been less severe, and there will have been less modification and less extermination. "All fresh-water basins, taken together, make a small area compared with that of the sea or land, and, consequently, the competition between fresh-water productions will have been less severe than elsewhere; new forms will have been more slowly formed, and old forms more slowly exterminated. It is in fresh water that we find seven genera of Ganoid fishes, remnants of a once preponderant order; and in fresh water we find some of the most anomalous forms now known in the world, as the Ornithorhynchus and Lepidosiren, which, like fossils, connect, to a certain extent, orders now widely separated in the natural scale." *

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* "Origin of Species," p. 107.

Order 4.—CTENOIDEI.

Fish with scales like the teeth of a comb.

Ctenoid fish, or fish with pectinated scales, are divided into many families. None are more ancient than the Chalk formation. The common Perch is a good type of the Ctenoid. The Climbing Perch of India (Anabas) is an example of extraordinary adaptation of structure. This fish not only creeps along the land, but even climbs trees, by means of spines on its gill lids. If this fish was only known as fossil, how little would its habits have been suspected.

The Sea Gudgeon, or common Goby of the aquavivarium, is a Ctenoid, easy of examination; as also is the common Bull-head, or Miller's thumb (*Cottus gobio*). Professor Owen gives an engraving of an extraordinary ctenoid fish from the tertiary deposits of Monte Bolca. The dorsal fin is like the sail of a lugger, and the long-pointed ventral fins might have been used as a couple of walking-sticks. This is the Semiophorus, and the genus is extinct. There must have been good perch-fishing during the Tertiary epochs, judging from the number of Ctenoid fishes that have been reckoned by ichthyologists as fossil.* Smerdis, Beryx, and many other genera, are Ctenoids.

Order 5.—CYCLOIDEI.

Fish with circular scales.

The fishes of this order are distinguished by their rounded, smooth, and simple scales. There are many families, fossil and recent, as a glance at the list given

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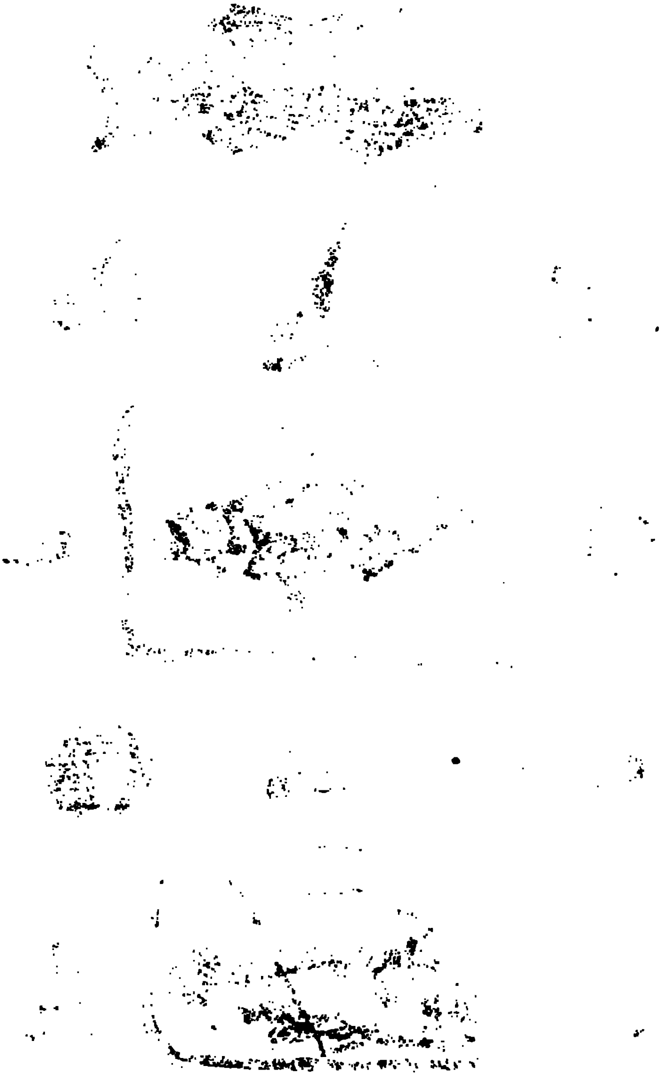
* See Jukes' "Manual of Geology," p. 335; Morris's "British Fossils;" and Pictet's Palæontology.



by Professor Jukes, from Pictet's classification, will prove.* No Cycloid fish has hitherto been found in strata older than the chalk. Professor Owen figures a small Turbot (*Rhombus minimus*) from the tertiary deposits of Monte Bolca, and mentions that an extinct Sole (*Solea antiqua*) has been found in tertiary muds near Ulm. We find also that fossil fishes of the cod, mullet, carp, salmon, and herring families are found in the tertiary formations, but are distinct from all known species; while from M. Pictet's list we gather that the tench, roach, dace, pike, anchovy, eel, and many others were abundantly represented in the Tertiary period. Professor Owen remarks as follows on the value of the evidence furnished by fishes. "Many creatures living on land may never be carried out to sea; but marine deposits may be expected to yield adequate grounds for general conclusions as to the character of the vertebrate animals that swarmed in the seas precipitating such deposits." With the knowledge now possessed respecting the long Cambrian and Silurian epochs, it is very extraordinary, certainly, if fishes existed prior to the deposition of the Upper Silurian deposits, that their relics should not have been detected.

The knowledge that there is a law of gravity, through which law the motions of planets around their suns, and satellites around their planets, take place; and that the law of the sun's attraction upon the planets is, that this attraction varies inversely as the square of the distance, is a knowledge that has raised the science of Astronomy to the proud position of a science that demonstrates great and irrefragable truths.

If, after the great discovery of Newton, astronomers and mathematicians had squabbled, and fought, and used hard names and theological arguments as to why the law we find in operation must obtain, and had insisted on reasons for the law, as squared to the chronology and astronomy of the Jews, instead of accepting the knowledge of the law as a law, and working on the basis of that knowledge, astronomy would not have been the science it now is.

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* Jukes' "Manual of Geology," p. 337.

The force of gravity is a mystery, the history of creation is a mystery, life is a mystery, all God's laws are mysteries. They are laws, nevertheless, and it appears to me that if we let the reasons why and how alone, and studied the effects of the laws more, we should be more likely to arrive at truth.

The examination of the principles of Palæontology and Biology has convinced philosophers that there is a "constantly operating, secondary, creational law;" while Owen has not hesitated to state his conviction in the "continuous operation of the ordained becoming of living things." With a knowledge of such laws as a basis, we look forward to a magnificent structure, yet to be reared by the investigations of geological, palæontological, and biological science; not indeed from theories as to whether certain inorganic atoms "flashed into life," but by the accumulation of FACTS, and by philosophical investigations of minute details connected with these established facts.

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